UNIV. OF
TORONTO
LIBRARY

Med.
A

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

EDITED BY H. M. IMBODEN, M.D.

VOLUME X

1923

JANUARY TO DECEMBER

19447
18.2.25

NEW YORK
PAUL B. HOEBER, PUBLISHER
MCMXXIII

Copyright 1923
By PAUL B. HOEBER

RM
845
A45
v.10

CONTENTS OF VOLUME X

ORIGINAL ARTICLES

Newer Investigations of the Problem of Roentgen-Ray Dosage . . . . *Otto Glasser, Ph.D.* 1
The Problem of Ray Dosage . . . . *Prof. W. Friedrich.* 6
Intestinal Reaction to Erythema Dose . *Charles L. Martin, M.D.* . . . . . *Fred T. Rogers, Ph.D.* 11
Important Points in the Technique of Roentgenological Examinations of the Urinary Tract . . . . . . *Bernard H. Nichols, M.D.* 19
New Light on Gastric Peristalsis. . . *Walter C. Alvarez, M.D.* 31
The Bone Lesions of Smallpox with Report of Cases . . . . *Francis B. Sheldon, M.D.* 35
The Diagnosis and Treatment of Bone Lesions: A Brief Summary of the Salient Features . . . . . . *Joseph Colt Bloodgood, M.D.* 42
Ionization Measurements. . . . . *Gioacchino Failla, E.E.* 48
Comparative Measurements between Radium and *X*-Rays Concerning Energy Absorbed at Depth . . . *Harvey R. Gaylord, M.D.* . . . . . *K. Wilhelm Stenstroem, Ph.D.* . . 56
Results and Technique in the Treatment of Carcinoma of the Breast by Radiation. . . . . *Burton J. Lee, M.D.* 62
An Automatic Switch for Bucky Diaphragms . . . . *Eugene Vernon Powell, M.D.* 67
A Note on the Use of the Bucky-Potter Diaphragm with the Fluoroscope . *Walter C. Alvarez, M.D.* 69
The Effect of the War on the Development of Roentgenology . . . . *Preston M. Hickey, A.B., M.D.* . . . 70
Studies of the Mechanism of Movement of the Mucous Membrane of the Digestive Tract . . . . *Gösta Forssell, M.D.* 87
Importance of Indirect Roentgen Findings in Chronic Infection of the Biliary Ducts and Gall-Bladder. . *M. P. Burnham, M.D.* 105
An *X*-Ray Study of the Absorption of Tuberculous Exudate within the Lung . . . . *Kennon Dunham, M.D.* . . . . . *Vera V. Norton, M.D.* 112
Deep *X*-Ray Therapy. . . . . . . *Reginald Morton, M.D.* 119
An Unusual Case of Double Spontaneous Pneumothorax. . . . . *Chas. P. Emerson, M.D.* . . . . . *Raymond C. Beeler, M.D.* 126
Anatomical Cross-Section Charts in Estimating *X*-Ray Dosage . . . . *Arthur U. Desjardins, M.D.* 134
Injuries from Roentgen Rays in Deep Therapy . . . . *Herman Wintz, M.D.* 140
Further Observations on the Radium Treatment of Cancer of the Esophagus with a Review of Forty-Four Cases so Treated . . . . *R. Walter Mills, M.D.* . . . . . *John B. Kimbrough, M.D.* 148

The Treatment of Superficial Cancer, with Statistics and Technique	*D. T. Quigley, M.D., F.A.C.S.*	161
A History Chart for Radium Therapy	*Carroll Chase, M.D.*	163
Two Important Points from the Radium Therapist's Standpoint Regarding Cancer Immunity	*Carroll Chase, M.D.*	167
New Growths within the Chest: *X*-Ray Diagnosis	*Samuel B. Childs, M.D.*	175
New Growths within the Chest	*J. N. Hall, M.D.*	182
Diaphragmatic Hernia of the Stomach	*Pedro L. Farinas, M.D.*	187
Sacroiliac Arthrosis Obliterans	*Edward S. Blaine, M.D.*	189
The Value of Grant's Pins in the Open Treatment of Fractures as Seen Roentgenologically	*D. Y. Keith, M.D.* *J. Paul Keith, M.D.*	195
The Effect of Small Doses of Roentgen Rays in Certain Forms of Impaired Hearing	*D. C. Jarvis, M.D.*	201
Treatment of Defective Hearing by Small Doses of *X*-Rays	*John McCoy, M.D.*	203
The Role of Radium Needles in the Treatment of Neoplastic Diseases	*William L. Clark, M.D.*	204
Suppurative Osteomyelitis of the Left Side of the Pelvis	*Irwin P. Levi, M.D.*	208
Glass Retained in the Hand and Foot	*Arthur S. Risser, M.D.*	210
Statistics and Technique in the Treatment of Malignant Disease of the Skin by Radiation	*Howard Morrow, M.D.* *Laurence Taussig, M.D.*	212
The Technique of the Treatment of Carcinoma of the Cervix Uteri with a Combination of *X*-Rays and Radium Rays	*Henry Schmitz, M.D.*	219
A New Radium Chart	*Lawrence A. Pomeroy, M.D., F.A.C.S.*	229
The Treatment by Radiation of Cancer of the Rectum	*Harry H. Bowing, M.D.* *Frank W. Anderson, M.D.*	230
Possible Dangers in Connection with the Use of *X*-Rays and How to Avoid Them	*John S. Shearer, Ph.D.*	240
Pneumoperitoneum	*Humberto H. Carelli, M.D.*	259
Report of a Case of So-Called "Marble Bones" with a Review of the Literature and a Translation of an Article	*William G. Alexander, M.D.*	280
Errors in Interpretations of Lesions of the Sinuses	*F. M. Law, M.D.*	301
Standardization of *X*-Ray Exposure Identification	*Edw. S. Blaine, M.D.*	303
A Biological Coefficient for the Aluminum Filter	*Francis B. Sheldon, M.D.*	307
A New Device for Retubing Radium Emanation	*Wilhelm Stenstroem, Ph.D.*	311

Principles of Radiotherapy of Carcinomata Especially of Uterine and Mammary Carcinomata	*Prof. Dr. E. Opitz*	312
Concerning a New Kind of Ray	*W. C. Roentgen*	320
Cardiac Pneumofibrosis	*George W. Holmes, M.D.* *Davis S. Dann, M.D.*	343
A Study of Lobar Pneumonia and Its Pulmonary Complications by Serial Roentgenographic Examination	*L. R. Sante, M.D.*	351
Prognosis in Tuberculosis of the Lungs from Examination by the *X*-Rays	*A. Howard Pirie, M.D.*	366
Enteroliths	*W. W. Boardman, M.D.*	369
Roentgen Therapy of Acute Infections of the Antrum and Frontal Sinus	*John D. Osmond, M.D.*	374
The Roentgen Therapy of Tinnitus Aurium	*Lyell Cary Kinney, M.D.*	378
The Value of the Roentgen Study of Mastoid Disease in Children under Five	*Wm. A. Evans, M.D.*	382
A Review of the Treatment of Hyperthyroidism by all Methods, with a Summary of the Authors' Experience with Roentgen Therapy	*Thos. A. Groover, M.D.* *A. C. Christie, M.D.* *E. A. Merritt, M.D.*	385
Protective Factors in Modern Highline *X*-Ray Work	*Albert Soiland, M.D.*	394
The Bacteriology of Irradiated Tonsils	*H. J. Ullmann, M.D.* *F. R. Nuzum, M.D.*	396
Measurement of Dosage by Means of Ionization Chambers	*William Duane, Ph.D., Sc.D.*	399
Isodose Charts	*Otto Glasser, Ph.D.*	405
The Immediate Effect of Radium and *X*-Rays on Enzyme Action	*S. Clement Roth* *John J. Morton, M.D.*	407
Carcinoma of the Small Bowel	*Milton M. Portis, M.D.* *Sidney A. Portis, M.D.*	419
Roentgen Gastrointestinal Studies of Patients with Chronic Deforming Arthritis	*R. G. Taylor, M.D.*	424
A Comparison of Clinical and Roentgenological Observations in Pulmonary Tuberculosis	*Frank S. Bissell, M.D.*	428
Pulmonic and Cardiac Changes Following Inoculation with Foreign Protein	*I. Edward Liss, M.D.*	435
The *X*-Ray in Neurological Diagnosis: Its Shortcomings and Possibilities	*Hugh W. Crouse, M.D.*	437
Annular Shadows: Are They Cavities or Spontaneous Pneumothoraces?	*Philip King Brown, M.D.*	445
Case of Bullet in Heart with Recovery	*F. C. Swearingen, M.D.*	454
The Lumbar Transverse Processes	*Morris I. Bierman, B.S., M.D.*	456

Treatment of Carcinoma of Esophagus by Deep *X*-Ray Therapy . . . *A. H. Pirie, M.D.* 459
Carcinoma of the Floor of the Mouth . *Douglas Quick, M.B.* 461
Intrathoracic Changes Following Roentgen Treatment of Breast Carcinoma *T. A. Groover, M.D.*; *A. C. Christie, M.D.*; *E. A. Merritt, M.D.* 741
A Review of the Present Status of Deep Roentgen Therapy . . . . . *Guido Holzknecht, M.D.* 476
Practical Roentgen-Spectrometry and its Physical Basis . . . . *Privat-Dozent Dr. K. Staunig* . . . 479
Standardization of Ionization Measurements of Intensity and Measurements of Scattered and Secondary *X*-Rays Effective in Producing an Erythema . . . . *J. L. Weatherwax, M.A.*; *Eugene T. Leddy, M.D.* 488
Discussion on Paper by Prof. William Duane on Measurement of Dosage by Means of Ionization Chambers. *Otto Glasser, Ph.D.* 493
Stereoscopy of the Accessory Sinuses . *G. W. Grier, M.D.* 497
Observations on Osteitis Deformans . *Sherwood Moore, M.D.* 507
Complete Anterior Dislocation of the Distal Epiphysis of the Femur . . *Theodore West, M.D.* 519
Secondary Signs of Gall-Bladder Pathology . . . . *Ralph D. Leonard, M.D.* 521
The Roentgenographic Study of the Mucosa in Normal and Pathological States . . . . *Richard A. Rendich, M.D.* . . . 526
A Case of Syphilis of the Stomach . . *Samuel F. Weitzner, M.D.* . . . 537
Report of a Case of Adeno-Papilloma of the Stomach . . . . *I. S. Ingber, M.D.* 539
Diagnosis of Obscure Abdominal Lesions by the Roentgen Gastrointestinal Examination . . . . *W. H. Dickson, M.D., C.M.* . . . 540
X-Ray Diagnosis of Unusual Laryngotracheal Esophageal Conditions and Diseases . . . . *Samuel Iglauer, M.D.* 547
Coccidioidal Granuloma . . . . . . *Raymond G. Taylor, M.D.* 551
Preliminary Observations of Cardiac Measurements in Children . . . *R. M. Tyson, M.D.*; *F. F. Borzell, M.D.* 559
Water-Cancer or Gangrenous Stomatitis Treated with the *X*-Ray . . . . *J. W. Cathcart, M.D.* 561
A Device to Prevent the Omission of a Filter in Deep Roentgen Therapy . *George E. Pfahler, M.D.* 562
A New Tube Holder for Roentgen Therapy . . . . *Thos. A. Groover, M.D.*; *A. C. Christie, M.D.*; *E. A. Merritt, M.D.* 564
Deep Roentgenotherapy in the Treatment of Carcinoma of the Breast . *George E. Pfahler, M.D.* 566
A Simple Nomogram for the Determination of Radium Skin Doses . . *Edith H. Quimby, M.A.* 574

Roentgen Therapy in the Treatment of Nasal Polypi . . . *James G. Ware, M.D.* . . . 579

Roentgen-Ray Study of Non-Luetic Periosteal Bone Lesions . . . *Roy H. Giles, M.D.* . . . 593

The Intestinal Rate and the Form of the Feces . . . *Francis Lowell Burnett, M.D.* . . . 599

A Bucky Diaphragm with Wide Slits . . . *W. L. Snider, M.D.* . . . 604

Report of Three Unusual Abdominal Cases . . . *Carl H. Parker, M.D.* . . . 605

Localization of Brain Tumors by Cerebral Pneumography . . . *Walter Dandy, M.D.* . . . 610

Dermatitis Artifacta Simulating Roentgen Dermatitis . . . *George M. Mackee, M.D.*, *George C. Andrews, M.D.* . . . 617

The Influence of *X*-Ray Therapy on Benign and Malignant Growths Dependent upon an Apparent Valid Distinction between Them . . . *Gottwald Schwarz, M.D.* . . . 622

Recent Developments in Protective Methods and Appliances as Used in Radium Therapy . . . *Curtis F. Burnam, M.D.*, *Grant E. Ward, M.D.* . . . 625

The Resistance of the Thyroid Gland to the Action of Radium Rays. The Results of Experimental Implantation of Radium Needles in the Thyroid of Dogs . . . *J. O. Bower, M.D., F.A.C.S.*, *J. H. Clark, M.D.* . . . 632

A Radium Applicator for Small Lesions . . . *Nathan T. Beers, M.D., F.A.C.P.* . . . 643

Automatic Operation of the Potter Grid . . . *Paul C. Hodges, M.D.* . . . 645

A Simplified Roentgenographic Technique Based on Experimental Evidence . . . *Frank Liberson, M.D.* . . . 647

Results of Skin Tests Made to Determine an Objective Dose for Radium Radiations . . . *Archie L. Dean, Jr., M.D.* . . . 654

Wilhelm Conrad Roentgen: In Memoriam . . . *F. Haenisch, M.D.* . . . 661

Observations on the Lateral Position and Other Methods of Examination of the Renal and Gall-Bladder Areas . . . *Sir John Thomson-Walker, M.B., F.R.C.S*, *Robert Knox, M.D., M.I.E.E.* . . . 681

Acute Mediastinal Abscess: Report of Four Cases in Children . . . *Orrin S. Cook, M.D.* . . . 696

Examination of the Posterior Mediastinal Glands in the Early Recognition of Pulmonary Tuberculosis . . . *Lloyd B. Crow, M.D.* . . . 699

Osteochondritis Deformans Juvenilis . . . *B. R. Kirklin, M.D.* . . . 701

Typical Disease of the Second Metatarsophalangeal Joint . . . *Prof. Dr. Alban Köhler* . . . 705

Two Cases of Localized Metastatic Carcinoma of Vertebrae Without Demonstrable Primary Lesion . . . *Cyril P. O'Boyle, M.D.* . . . 711

Hypernephroma . . . *Harry B. Podlasky, M.D.* . . . 714

Roentgenographic Interpretation of Ileocolonic Stasis . . . . *Ernest Charles Samuel, M.D.* . . . 721

A Plea for the Use of the Roentgenoscope in the Diagnosis of Urinary Calculi *J. L. Tabb, M.D.* 722

Report of Results of *X*-Ray Treatment in Pyorrhea Alveolaris . . . . *G. Von Poswik, M.D.* 724

Fifteen Years' Experience with the Fractional Dose Method of Treating Cutaneous Malignancies. . . . *J. M. Martin, M.D.* 726

Radium Needles in Malignant Growths of the Tongue: The Time Factor . *A. James Larkin, M.D.* 734

The Radium Emanation Slide Rule for Use in the Field of Therapeutics . *John Ransom, B.S.* 735

Flat Diaphragm of Spiral Design in Roentgenography. . . . . . . *Harold Sawford* 737

Biological Reactions of *X*-Rays: Effect of Radiation on the Nitrogen and Salt Metabolism . . . . *Carl F. Cori, M.D.* . . . . *G. W. Pucher* 738

Deep Roentgen Therapy and Skin Reactions . . . . *P. Del Buono, M.D.* 745

Radium Treatment of Toxic Goiter with Metabolic Deductions . . . . *R. E. Loucks, M.D., C.M.* 767

Certain Biological Principles of Radiation Therapy. . . . . . . *Sanford Withers, M.D.* 776

A Study of the Action of Measured Radiation Doses on Carcinomata of the Uterine Cervix . . . . *Henry Schmitz, A.M., M.D., F.A.C.S.* 781

Results of Deep Roentgen Treatment of Gastrointestinal Malignancies . . *William A. Evans, M.D.* . . . . . *T. Leucutia, M.D.* 793

Treatment of a Case of Primary Mediastinal Tumor of the Lung by *X*-Ray After Medical Resources Were Exhausted. . . . . *Fred S. Eveleth, M.D.* 802

Results with Modern Radiotherapy in Bladder Tumors . . . . *Charles Goosmann, M.D.* 804

A Case of Tuberculosis of the Symphysis Pubis . . . . *J. B. Jackson, M.D.* 806

Roentgen Therapy of Chronic Prostatic Hypertrophy . . . . *J. Thompson Stevens, M.D.* 810

Roentgen-Ray Treatment of the Thyroid *E. L. Jenkinson, M.D.* 814

Clinical Problems in Roentgen Therapy of Deep-Seated Malignancy . . *Chas. L. Martin, M.D.* . . . . . *J. M. Martin, M.D.* 818

Biological Reaction of *X*-Rays: The Influence of *X*-Ray Treatment on the Complement Content of the Blood of Cancer Patients . . . *Carl F. Cori, M.D.* 830

Tumors of the Pituitary Gland . . . *Joseph T. McKinney, M.D.* 835

Importance of the Roentgen Examination in the Determination of the Proper Method of Treatment of Pulmonary Abscess . . . . . *W. H. Stewart, M.D.* 841

A Relatively Large Foreign Body in the Orbit	*Percy Brown, M.D.*	842
Fibrinous Bronchitis	*F. Hase Rodenbaugh, M.D.*	843
The Use of Radium in the Treatment of the Leucemias and Hodgkin's Disease	*W. H. B. Aikins, M.D.*	853
The Technique of Radiation Therapy of Esophageal Carcinoma	*James T. Case, M.D., F.A.C.S.*	859
Radium Therapy of Vascular Nevi	*Howard Morrow, M.D.* *Laurence R. Taussig, M.D.*	867
An Instrument for the Implantation of Bare Radium Emanation Tubes into the Tissues	*William Neill, Jr., M.D.*	871
The Treatment of Benign Hemorrhage of the Female Genitourinary Tract by Radiation	*Henry Schmitz, M.D.* *Harry E. Bundy, M.D.*	872
A Preliminary Report of the Action of Buried Radium on Diseased Thyroids in Man	*J. O. Bower, M.D., F.A.C.S.* *J. H. Clark, M.D.*	875
A Comparative Study of the Efficiency of Various Filter Materials	*Arthur W. Erskine, M.D.* *Scott W. Smith, M.S.*	881
A Water-Cooled High-Voltage *X*-Ray Tube	*W. D. Coolidge, Ph.D.* *C. N. Moore*	884
Measurements of the Absorption Coefficient of Water and Aluminum for Hard *X*-Rays	*Egon Lorenz, Ph.D.* *Boris Rayewsky, Ph.D.*	890
The Use of Isodosis Curves in *X*-Ray Therapy Showing the Inaccuracy of the Dessauer Charts	*Charles Gottlieb, M.D.*	896
Advances Made in the Roentgen-Ray Study of Gall-Bladder Disease	*Dorwin Palmer, M.D.*	901
Diverticulum from the Anterior Surface of the Stomach Near the Cardio-Esophageal Junction	*Leonard J. Ravenel, M.D.*	904
Rapidly Developing Complete Pyloric Stenosis: Report of a Case	*Harold Swanberg, B.Sc., M.D.*	905
An Unusual Shadow in the Head Interpreted as Calcification in the Left Lateral Ventricle	*A. Robert Taft, M.D.*	907
Errors in the Diagnosis of Foreign Bodies in the Air Passages	*Porter P. Vinson, M.D.*	908
Chinese Bound Feet	*Joseph L. Harvey, M.D.*	911
A Simple Method of Immobilizing Patients in the Standing Position	*C. Harvey Jewett, M.D.*	915
Time-Saving Device for Skin Therapy	*Sze-Dau Tsiang, M.D.*	917
Ionization Methods of Measuring *X*-Ray Dosage	*William Duane, Ph.D., Sc.D.*	935
The Economics of Dosimetry in Radiotherapy	*Gioacchino Failla, E.E.* *Edith H. Quimby, M.A.*	944

Studies on the Biological Effects of *X*-Rays . . . . *James W. Mavor* 968

The Occurrence of Two Heritable Types of Abnormality among the Descendants of *X*-Rayed Mice . . . . *C. C. Little, Sc.D.* . . . . *H. J. Bagg, Ph.D.* 975

Forceps for Cleaning Radium Needles and Tubes . . . . *J. S. Ullman, M.D.* 989

V

THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. X JANUARY, 1923 No. 1

NEWER INVESTIGATIONS OF THE PROBLEM OF ROENTGEN-RAY DOSAGE*

BY OTTO GLASSER, PH.D.

BALTIMORE, MARYLAND

GRATEFUL acknowledgment is due your society for this opportunity of presenting the results of the investigations carried out with my honored chief, Prof. Friedrich, of Freiburg. Lack of time prevents a detailed report here of our work, but I would like to call your attention to our article[1] which contains the complete results.

Although ten years have passed since the appearance of the classical work of Christen,[2] on the problem of roentgen-ray dosage, there are still many questions which are not clearly understood. This uncertainty attaches not only to the working out of practical means of determining the dosage, but also exists in reference to the purely mathematical formulating of a dosage law. Since, however, the question of dosage is evermore to the front, Prof. Friedrich and I have decided to combine a general discussion of the entire problem with the report of our investigations. In these investigations there has been maintained a sharp distinction between the problems of *absolute dosage* and of *relative (practical) dosage.* The solution of the problem of absolute or scientific dosage, built upon the knowledge of the mechanism of ray-effect, should lead to the construction of an ideal dose-measuring apparatus. A modest contribution to the solution of this complicated question is what I here propose to present to you. In the next paper, Prof. Friedrich[3] will consider the entire problem of dosage. There, the help of the most modern conceptions of physics is utilized to illuminate the obscurity of both the absolute and the relative dosage.

For measuring ray-dosage, Kroenig and Friedrich[4] developed a method which depends upon ionization measurements; and this led to the construction of the iontoquantimeter. From a study of the absorption and ray diminution, they concluded that it was possible to construct an ionization chamber out of electrodes and gases of low specific gravity; and these apparatuses sufficed to compare measurements of rays of different wave-lengths. Their conclusions appeared to be supported by the agreement of the measurements obtained with little ionization chambers and those obtained with the so-called wall-less chamber, which latter is effected only by the secondary beta rays developed in the gas. These conclusions have now been questioned from various sources, especially on account of the fact that the knowledge of the scattering of roentgen rays and energy-relationships of the secondary beta rays has been greatly increased. Investigations showed that the capacity of the wall-less chamber of Friedrich was too small for the comparison of the range of the secondary beta rays coming from the hard roentgen rays. As a consequence, the measured electrical effect was too small for the hard, as compared with the soft, rays. As early as 1914, Duane[5] called attention to the fact that large ionization chambers must be used to measure the whole ionization effect of the secondary beta rays. But ionization chambers, even of the size recommended by Duane, were not large enough to measure the effect when using the short wave-length rays. This fact led Holthusen[6] to the construction of very large ionization chambers; it is also Holthusen, who, through a series of noteworthy works, showed the importance of the secondary beta rays on the dosage measuring apparatus. In the Radiological Institute of the University of Freiburg, we had already begun to work on similar problems before the appearance of Holthusen's publications, and only a brief report has been possible; this was given at the "Deutsche Roentgentagung" of 1920 in Berlin.

---

*Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

If one starts with the hypothesis that the number of ions produced from the secondary beta rays, developed from the roentgen rays in a definite radiated volume, is a measure of biological effect, then care must be taken that the full amount of these ions be measured. Since we, in our investigations, employed roentgen rays corresponding to an average wave-length of about .16 ÅU developed from a tension of about 200 kv., therefore, an ionization chamber of corresponding magnitude must be chosen. Since the range of the beta rays expelled from these hard roentgen rays is more than 15 cm., only a large chamber can measure the full electrical effect of these rays. The construction of our ionization chamber met these requirements. I can only briefly describe the measuring apparatus. Figure 1 shows a small diagram of the apparatus. F is the large zinc wall ionization chamber and K the small horn chamber of Kroenig and Friedrich. The length of the large chamber is 35 cm., the width is 32 cm. In the center of the large ionization chamber is an electrode of graphited paper in the form of a ring, r, which arrangement is favorable for the electrical field distribution. The interior electrode of the horn chamber is a graphite pencil. From both electrodes there run well-insulated connections over the switch Sch to the Wulf electrometer El. From the entire roentgen-ray bundle from the tube R, two small equal bundles are separated by the lead screens B, through which conveniently placed holes have been made. One bundle goes to the larger chamber and the other to the smaller. In a conveniently arranged holder on the lead screen, filters of various materials and thicknesses can be brought over the holes. Figure 2 shows the arrangements of the two chambers.

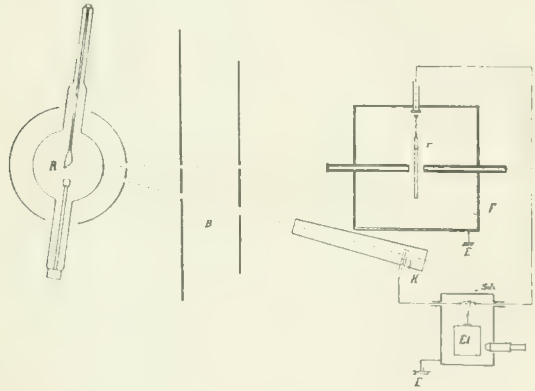


Fig. 1.

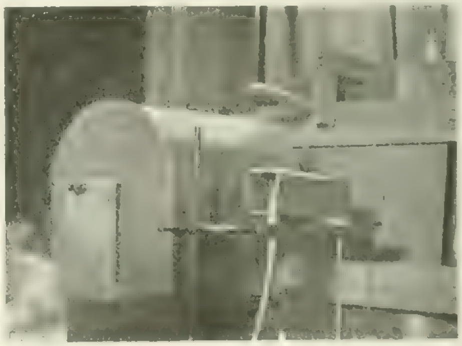


Fig. 2.

All parts of the apparatus are electrostatically protected and grounded in the very best manner possible; against adventitious rays, a thick lead housing is put over all parts of the apparatus. The tube R is a Coolidge tube with tungsten target operated with a "Sanitas-Hartstrahl Apparat." The cathode filament is heated by a storage battery, which, with a constant regulated primary current permits of perfectly stable conditions. The process of the measuring was that in general use. The time of the fall of the quartz thread through a definite part of the scale of the electrometer was noted both for the large and small chambers under varying conditions; the values obtained for the large chamber were divided by those of the smaller chamber. Of course, all sources of error of this electrostatic arrangement were exactly determined. The actual readings were corrected mathematically, in order to remove these sources of error. Great care was taken to avoid any errors in the reading of the ionization current in the two chambers, due to the azimuth effect of the tube. For the investigations, 5 separate ranges of wave-lengths, determined by sphere-gap measurements and spectrograms, were employed. These groups are represented as H_1, H_2, H_3, H_4, H_5, and correspond to average wave-lengths of .43, .32, .25, .20, .16 Angström units. An accurate description of the measuring apparatus, of the sources of error, etc., has appeared in the above-mentioned report.[1]

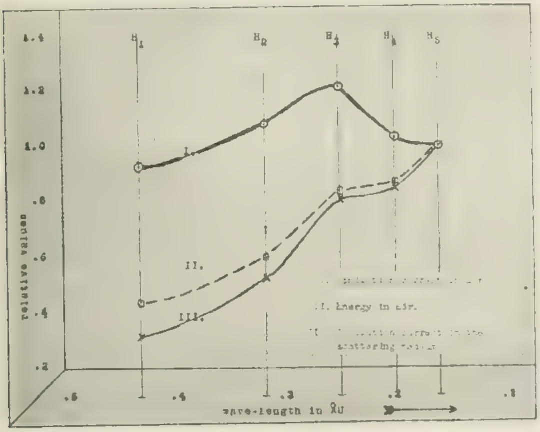


Fig. 3.

We will pass directly to the result of a comparison of the Friedrich horn chamber with the large ionization chamber, and pass over the technique of the experiments. Figure 3 shows three curves. The abscissae represent the wave-lengths; the particular average wave-lengths H_1 to H_5 used are marked. The ordinates represent the values of the quotient when the results of the small ionization chamber are divided by those of the large in relation to the value of the hardest rays H_5.

Curve I represents the values of the ionization currents in the small and large chambers, thus showing the errors made by the small chamber measurements. One sees that the quotient at first goes up with shorter and shorter wave-lengths, and then becomes smaller again. The variations from the quotient 1, are due to the fact that the amount of radiation from the walls of the small chamber increases with the shorter wave-lengths, whereby a stronger ionization takes place in the small ionization chamber. If there were no sources of error in the small chamber measurements, the results would be identical with those obtained by the large chambers, and the quotient would be one. Further shortening of the wave-lengths increases the range of the wall radiation beyond the diameter of the small chamber, and therefore, the secondary beta rays cannot produce their complete ionization effects: the quotient of the ionization currents becomes smaller.

Curve II in Figure 3 takes a different course. It represents the values of the quotients of the energies of the secondary beta rays for the larger and smaller chambers. These energy values can be directly calculated by the ionization currents, by means of the dependence of the ionization upon the energy of the secondary beta rays on the one hand, and from the Planck-Einstein formula (verified by Duane and Hunt), on the other hand. This energy curve shows that with the shorter wave-lengths, the energy, as measured by the small chamber, in comparison to the ionization effect, steadily increases.

I have shown these two curves because they are characteristic of two theories of dose measuring, i.e., the ion theory and the energy theory. The first states that the number of ions produced in an ionization chamber affords a measure of biological effect, the second that the energy of the secondary beta rays affords a measurement of the biological effect.*

What, according to our measuring results, can be expected as to a determination of dosage by small ionization chambers?

For measuring dosage of differing wave-lengths, the small chamber, at first sight, does not satisfy either theory; e. g., what does curve I show about dosage from the ion theory standpoint?

---

* See the investigations of G. Failla,[7] and others.

In the region of the soft rays (up to .34 ÅU) the dose as measured by the small horn chamber with increased hardness would be too great. As a result, the biological object radiated would receive, with shorter wave-lengths, too small a dose as compared with the soft rays. As a result of this, as measured by the horn chamber, the short wave-length rays seem to have less biological effect than the longer wave-length rays. In the region of the hard rays (beyond .34 AU), one sees that the curve I falls again, and therefore, with shorter wave-lengths the dose as shown by the measuring apparatus is too small. Consequently the dose to a biological object as compared to relatively softer rays is too great. Therefore the extremely short wave-lengths would have a more favorable effect.*

Let us now pass to the dosage by the energy measuring of the secondary beta rays. Curve II shows here that the measured energy steadily rises with shorter wave-lengths. It is evident that the short rays would produce here in the horn chamber much more effect than the long waves, and that, as a consequence, a biological object will receive too small a dose if short waves are used.

To sum up: it is evident that in the construction of biological rules determined by small ionization chamber measurements, it is necessary to make certain corrections, whether the ion theory or the energy theory is employed.

As a matter of fact, series of such biological rules are in existence, on the one hand, from the ionization standpoint, and on the other, from the energy standpoint; the first group is fairly represented by Kroenig and Friedrich,[4] and the second by Holthusen.[6]

In order to test these two theories, Holthusen conducted a series of investigations in which he standardized his small aluminum chamber by means of a large chamber. By this means he was able to show that in radiating the "Ascaris megalocephalus" the energy theory will agree with the biological effect, quite independent of the wave-lengths employed. In contrast with this, an assumption of the ion theory showed that there was a quality difference between the different wave-length doses, in the sense that the short wave-length rays seemed to be less effective.

Very different conclusions were reached by Kroenig and Friedrich, who, in their well-known biological investigations in determining dosage only by measuring the ionization current in the small horn chamber, found no dependence of biological effect upon wave-length; these experiments were made upon plant, animal and human tissues.

This discrepancy has been much discussed and misunderstood and the results of the investigators have been repeatedly put under suspicion. The apparent disagreement of these results is explainable, if one takes into consideration the additional dose of the scattered radiation, which takes place in the radiated medium.

Holthusen employed for his investigations as small a test object as possible; he did this from theoretical considerations, in order to have conditions as nearly as possible like those in the ionization chamber. The use of larger objects—in particular, the human tissue by Kroenig and Friedrich—corresponds more closely to the practical use of the rays, but adds to the direct radiation a marked amount of scattered radiation. Smaller test objects (tadpoles and germinating beans) were intentionally radiated in large water vessels, in order to reproduce exactly the same conditions as to the scattered radiation.

We measured, with the apparatus described above, the scattered radiation for the region of the wave-lengths H_1 to H_6 by putting the small ionization chamber down into the scattering medium; it is evident that the scattered radiation has a great influence upon the consideration already mentioned in connection with the ionization curve I in Figure 3. This influence of the scattered radiation, added to the direct radiation, both measured by the ionization current in the small chamber, is shown in curve III in Figure 3. It is apparent that this curve takes an entirely different course with shortening wave-length from that shown in curve I, which shows the ionization current measured in air. *Moreover, it is evident that the ionization measurements made in the scattering medium* (see curve III) *correspond to the measurements of energy made in the air* (see curve II).

---

* These results have been in part reported also by other observers, and it is therefore urgently necessary, in comparing their results with ours, to have the exact data as to the range of wave-lengths used.

By way of résumé, allow me to repeat that Holthusen employed test objects of very small size, and came to the conclusion that the biological effect was independent of the wave-length over a definite scale of wave-lengths, when he applied a definite correction factor, and by this means calculated the ionization currents in terms of energy. In contrast with this, there was a distinct difference in biological effect, when measured by the ionization current alone. Kroenig and Friedrich used large test objects and dosed by the ionization current measurements. It is evident (see curve II, showing the energy, and curve III, the ionization, in the scattering medium) from our investigations that the additional effect of the scattered radiation approximately equals the correction factors employed by Holthusen for estimating the energy of the secondary beta rays. As a result of this, the direct readings by Kroenig and Friedrich *automatically supply the right correction, and the applied dose is the same as by the energy theory.*

Our investigations would not be complete if we neglected to consider chambers of other materials; for instance, of materials which can easily be sterilized and are of low atomic weight. I will limit myself, however, to a consideration of an aluminum chamber of ⅛ mm. wall thickness and to a very thin graphited paper chamber. In the case of the aluminum chamber, the course of the three curves is very similar to that obtained with the horn chamber. However, the maximum is higher, due to the fact of the greater influence of the wall rays. Of interest are the results of the measurements shown when the aluminum chamber was brought into a large scattering medium. It was found, as was known formerly, that there must be a difference in biological effect with different wave-lengths when one employs the ionization currents as a measure of dose.

Where a thin graphited chamber is used as ionization chamber the three curves are not so very different from each other. The biological results obtained by the two theories would here be almost identical.

I will not detain you longer now, but refer you to the detailed report in *Strahlentherapie.*

I hope, however, that this short presentation has given you an understanding of the great importance of these questions of dosage. You see that our investigations not only present an accurate and critical picture of what takes place in the small ionization chambers, but they may, perhaps, throw light upon the essential biological action of the rays in tissue.

This represents the most pressing problem immediately before us today.

BIBLIOGRAPHY

1. Friedrich, W. and Glasser, O. Untersuchungen und Betrachtungen über das Problem der Dosimetric. *Strahlentherapie,* 1922, xiv.
2. Christen, Th. Messung und Dosierung der Roentgenstrahlen. Hamburg, 1913.
3. Friedrich, W. The problem of ray dosage. Am. J. Roentgenol., 1923, x, I.
4. Kroenig, B. and Friedrich, W. Die physikalischen und biologischen Grundlagen der Strahlentherapie. Berlin, 1918. English edition, New York, 1922.
5. Duane, W. Meeting of The American Roentgen Ray Society at Cleveland, Ohio, 1914.
6. Holthusen, H. *Fortschr. a. d. Geb. d. Röntgenstrahlen,* 1919, xxvi and xxvii.
7. Failla, G., Quimby, E. and Dean, A. Some problems of radiation therapy. Am. J. Roentgenol., Aug., 1922, ix, 8.

THE PROBLEM OF RAY DOSAGE*

BY PROF. W. FRIEDRICH

FREIBURG, GERMANY

WE greatly appreciate this opportunity of laying before you some of our thoughts about ray dosage.

In the paper of my collaborator, Glasser, you have heard of a series of investigations which showed that there are entirely contradictory biological effects according to the working hypothesis applied to interpretation measurement of ray dose, independent of wave-length. It seems opportune to explain the theory of dosage itself before beginning a general discussion of the subject. Christen expressed the conception of the dose which a little volume of any radiated medium receives, by the formula

$$1.\quad D = \frac{I \times t}{h}$$

This is the so-called "physical dose," and does not take into account the transformations of energy which lead directly to biological effect; Christen accounted for this by adding a factor σ to the physical dose. This factor shows the part that this dose has in the direct biological effect.

Our conceptions today as to the nature of the emission and absorption of rays have been influenced through a series of investigations expressed in the Einstein-Planck formula (verified by Duane and Hunt).

$$V \times e = h \times \nu$$

$$2.\quad \tfrac{1}{2} m \times v^2 = h \times \nu$$

It is, therefore, necessary to define more precisely our conception of intensity. (In the Einstein formula, V denotes the maximum tension, e the elementary quantity of electricity, h the Planck constant, ν the frequency of the rays, m the electromagnetic plus the real mass of the electron, v its velocity.)

By the intensity of radiation is meant the energy falling upon a unit of surface in the unit of time; this may be written

$$3.\quad I = \frac{E}{f \times t}$$

The problem is now to determine the value of the energy E. Simple explanations seemed necessary, as the non-physicist is the person who will be practically interested in these considerations. For this reason, the process of the origin of the non-characteristic roentgen rays and the distribution of the energy they give rise to, will not be considered, since as yet these processes have not been completely investigated. They are very complicated and not essential to the discussion of the problem.

Let us imagine, therefore, a non-polarized monochromatic radiation, such as, for example, in one of the spectrum lines of the target material of a tube. Let the energy of the roentgen rays produced by the energy of a beta ray of $h \times \nu$ be $h \times \nu$. This energy is distributed upon a spherical surface whose center is the anticathode, and propagates itself with the velocity of light. In a square cm. we therefore have a surface energy of this elementary radiation of

$$4.\quad F = \frac{h \times \nu}{f} = \frac{h \times \nu}{4\pi r^2}$$

The energy produced during any period of radiation is evidently proportional to the number of elementary radiation processes; accordingly

$$5.\quad F_n = n\frac{h \times \nu}{4\pi r^2}$$

For the energy emanating in the unit of time through the unit of area, in other words, the intensity, we can accordingly write the formula

$$6.\quad I = \frac{n \times h}{4\pi r^2 t}$$

If we add the duration of radiation, there results the equation

$$F_n = I \times t$$

There is still another important factor, i.e., the absorption coefficient of the object radiated. By this is meant the reciprocal thickness of a layer necessary to absorb the radiation applied, to the e^{th} part. This is expressed in the well-known law of absorp-

$$7.\quad I_d = I_o \times e^{-\mu d}$$

---

*Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

tion in which I_o and I_d represent respectively the impinging and the radiation passing from the medium, d the thickness of the penetrated layer, μ the coefficient of absorption and e the base of the hyperbolic system of logarithm.

If a radiation of the surface energy expressed by formula 5 falls upon a small unit volume of the absorbing substance which is of d thickness, then the dose received per unit of surface will be

$$8. \quad D = F - F_o$$

$$\text{i.e. } D = \frac{n.h.\nu}{4\pi r^2}\left(1 - e^{-\mu d}\right)$$

In the above formula the influence of the inverse square law has not been taken account of.

Scattering. A part of the entering energy of a roentgen-ray bundle is transformed in passing through a medium to some extent into scattered radiation. Another part of this entering energy is absorbed in the production and driving of the secondary beta rays. This latter portion is now-a-days referred to as absorbed energy and in the formula is expressed by μ. It is only in recent years and by the use of very penetrating rays that the importance of these factors in practical dosage has been recognized.

Since the scattering radiation in any medium larger than a single atom gives rise to an exactly similar dosage in surrounding atoms, it is obvious that this simple characteristic dosage formula cannot be maintained. The additional dosage dependent on scattered radiation must be expressed by a definite factor. An attempt to fix mathematically the amount of additional dose due to scattered radiation as reported by Glocker and his collaborators complicates and well-nigh makes impossible a single presentation of the subject. The factors which determine the dosage are the same as in the direct dose just explained, but the functions are greatly complicated by the different distances of the centers of scattering, and the consequent different thicknesses of medium passed through. Suffice it to say that the additional dose constitutes a function of the scattering, and can be expressed by

$$9. \quad D_2 = f(S)$$

For the total dose received by a volume element at a distance r from the source of radiation we get the formula

$$10. \quad D = \frac{n.h.\nu.t}{4\pi r^2 t}\left(1 - e^{-\mu d}\right) + D_2$$

$$\text{i.e. } D = (I_a + I_s).t.(1 - e^{-\mu d})$$

Accordingly the dose is proportional to the total intensity $I_a + I_s$(I_a is the direct, I_s the scattering intensity) entering the volume; it is furthermore proportional to the time of radiation t, and to the absorption coefficient μ, or, expressed in another way, inversely proportional to the half value layer.

It is evident that the essentials of Christen's formula are preserved; the introduction of the expression $h \times \nu$ makes possible a much more detailed consideration of the relation which exists between the energy of radiation and that of absorption. We shall not discuss this here, however.

Problem of Dosage. The problem of dosage is the development of means and methods which will permit of actual measurements of the values theoretically defined in the preceding paragraphs. During a radiation the observable changes that take place in a living object are practically nil; they develop some time after the radiation. There is, therefore, no biological method for directly measuring the dose. For this reason it is necessary to turn to chemistry and physics for additional help.

It is essential, just as in case of every measurement of energy, that one or more energy transformations be followed and measured. The measuring apparatus should contain, as a chief constituent, a substance that is changeable under the influence of radiation energy. It is evident that the transformations which take place in the measuring apparatus should be the same as those in the material to which the dose is applied. For the most part, these are living objects, and identical changes are, of course, not always obtainable. But at any rate, the transformation of energy must conform to the same laws with reference to the dependence of measurable transformations of energy proportional to the determining of factors. It is essential that the measuring apparatus and the test object should absorb the rays, whatever the wave-length may be proportionally, in order that the apparatus may be used as a practical instrument when rays of different wave-lengths are employed. In order to find a test object which will meet the needed conditions, it is essential to understand the effect of the radiation in a biological object. Unfortunately, the numerous previous investigations in this line afford us little help. The processes underlying the simplest photochemical changes in non-living substances produced by roentgen rays or light are not completely understood. In the absence of clearly understood processes we are, therefore, in the working out of a process of dosage measurement, limited, for the present, to hypothesis. As an illustration, Glasser has just shown that the hypothesis may be maintained that the number of ions formed in the biological object during radiation– in other words, the electrical effect—determines the biological change. Under this hypothesis it is first necessary to secure a measuring substance which permits the number of ions formed in it to be measured. It must furthermore satisfy other demands; for example, the conditions of absorption and scattering must be identical or directly proportional to those taking place in the living object tested. Air is such a test body. Providing that a definite size of such a test body and uniform conditions be maintained in relation to the biological object to be measured, it is possible to establish a measure of dosage of varying wave-lengths, and to formulate rules which permit of the determination of the extent of the biological effect from any given amount of any wave-length. It was clear from Glasser's paper that where this hypothesis is employed, hard rays seem to have a less biological effect than soft rays, but also that scattering rays lead to deviations from the rule.

It is possible to work with another hypothesis which is also very plausible, i.e., that the energy of the secondary beta rays determines the biological effect; in the paper of Glasser it has been shown that the energy of the secondary beta rays and the number of ions formed by radiation do not run parallel when waves of different lengths are tested.

It is evident that when this energy theory is employed, a method must be devised that permits of energy measurements. You have seen that it is possible to construct a measuring apparatus which meets this need, provided that certain fixed factors are recognized and corrected for. The rules of dosage formed by this method do not agree with those deduced from the ion theory when they are applied to a determination of the amount of biological effect with rays of different wave-lengths.

Furthermore, still other hypotheses are possible; for example, it may be assumed that the roentgen rays have a direct biological effect without the formation of electrons; this is supported by the investigations of Lenard and Ramsauer, which showed that photochemical processes take place under the influence of light without the formation of ions.

A further important factor is the size of the radiated biological object. The biological effect in a small object where a definite intensity of a definite wave-length is used is quite different from that in large objects under the same conditions. Further investigations which will show the influence of volume upon the dose are greatly needed. It should be firmly held in mind that the principles of dosage measurements given have taken into account only the "density of the dose."

These simple examples show how difficult the solution of the *absolute dosage* problem is. It can only be attained by thorough systematic investigation, in which physicists, chemists and biologists must cooperate in creating the foundations. It is important to study *in vitro* all known processes which may in any way play a part in the biological changes induced by radiation. Phenomena of like kind must be brought together under definite rules. When these processes are clearly understood under the simpler conditions, then it will be possible to apply them to a study in the living organism. It is quite certain that the immediate future is not likely to show what these biological effects are. We have merely to think of the multitude of complex catalytic and fermentative processes which take place in the living body, to realize the magnitude of the task.

It is an incentive to systematic and thorough work to realize that these problems once solved will have a tremendous influence on the practical employment of roentgen rays as a therapeutic agent.

Practical (relative) Dosage. It is, of course, not possible to defer the entire practical application of roentgen-ray therapy until perfect measuring apparatus is developed. The conditions required for practical dosage are entirely different from those above outlined. Practical medicine seeks to put into reproduceable form the biological phenomena established by experience. From this point of view, much less severe demands are made upon a measuring device. There are two main requirements: (1) The instrument must be sufficiently sensitive to record small differences in dosage used in practice; (2) the instrument must be reliable, so that under the same conditions of radiation it will always record the same results. These processes do not measure the dosage in the above-defined theoretical sense. For the sake of simplicity, however, we shall designate the magnitude measured as dosage.

Dosage-measuring Apparatus. The processes used in medicine for measuring dosage meet these two demands in a greater or lesser degree. One may divide them into two groups:

1. Measuring the dosage at the point where the effect is desired.
2. Measuring the working conditions, which include calibration of tubes and apparatus.

The old methods of dosage, such as the Kienboeck strip and the Sabouraud-Noiré tablets are today considered unreliable on account of their lack of sensitiveness.

Modern measuring methods are based upon measuring the change in resistance of selenium (Fuerstenau intensimeter) or on measurement of ionization. The latter processes are recognized as more reliable. The construction of the ionization apparatus has reached such a degree of simplicity that it may be competently used by those who are not physicists.

The instruments to be mentioned here are the "iontoquantimeter" with the small horn ionization chamber previously described, the aluminum chamber with galvanometer of Duane, the "iontoquantimeter" as invented by Hammer, the "iontoquantimeter" of the Standard *X*-Ray Co., the "ionometer" invented by Wulf, the "Siemens Roentgen dosimeter," the "Veifa Electroscope," the "ionimeter," by Martius, the *x*-ray measuring apparatus of Roy Kegerreis, and others.

The first method, that is, measuring the dose at the point where the effect is desired (direct dosage) is carried out by these instruments partly in the form of a permanent measurement. For example, the iontoquantimeter measures the dosage for the entire duration of the radiation, and thus takes account of all the variations in the conditions of operation. With instruments of the Veifa electroscope type, the measurements must be made before or after the treatment; and with tubes of the Coolidge type, the results are dependable.

In the second method, it is necessary to determine the working conditions of tube and apparatus, which factors are necessary to compute the dosage. These factors must include the strength of current and the tension or hardness, and the knowledge of the technique of radiation and filtration. The second method also includes measurements, which, with the aid of a water phantom, or one of wax or wood, furnish data concerning the distribution of the intensity or of the dosage at the surface and in the interior of the object to be radiated. The use of these measurements in phantoms demands a verification of the constancy of the conditions of operation when they are employed for the biological object. Since the technique always remains the same in the case of a number of objects which are subjected to radiation, especially in gynecology, the results once obtained for a given case have been tabulated to indicate the distribution of intensity (e.g., see charts of Dessauer and Vierheller or tables of Duane or others) so as to avoid constant repetition of the same measurements with phantoms. Such tables can be used directly for radiation purposes, since the conditions of measurements are the same.

Finally, a combination of both methods may be employed. This consists in the fact that the first method measures the dosage on the surface of the object to be radiated, and the second method gives the data concerning the rays to be employed and other conditions (size of field, focus skin distance, etc.) and enables one to draw conclusions as to the distribution of the intensity in the object radiated.

In conclusion, let us point out once more the importance of an exact formulation of the problem of dosage. In the above presentation we intentionally drew a sharp line of demarcation between the problems of *absolute dosage* and *relative dosage* of roentgen rays. All the investigations concerning the question of *absolute dosage* were undertaken to throw light upon the possibility of the establishment of an absolutely exact method to measure the dosage. In order to attain this, a knowledge of the nature of the action of the rays is absolutely essential. Only then will it be possible to discover further laws concerning the biological effect of rays of different degrees of hardness; that it can be attained only by systematic research work we have already demonstrated.

The *relative dosage* methods of medical practice are suitable to give the practitioner, the clinical expert, and the radiotherapist the possibility of attaining reproducible physical conditions in the clinical applications of the rays. Naturally, various investigations can also be made with these measuring processes, and various biological problems can be solved; under this head may be grouped all those questions which concern radiation effects of a given degree of hardness. In all investigations where rays of different degrees of hardness are compared with each other by means of one of these dosage processes, be it by the theory of energy, the ion theory, or a chemical theory, no absolute laws can be posted at present, especially since the biological results obtained on the basis of the theory may yet be influenced by technique. At present we cannot give preference to one or another theory.

To continue investigation of *absolute dosage* is the chief task of the physicist in collaboration with the biologist and the chemist; independent investigation will hardly lead to the goal. In the matter of *practical dosage*, the physicist has done his part for the time being; now it is the task of the clinical investigator to continue the work along these lines.

INTESTINAL REACTION TO ERYTHEMA DOSE*

BY CHARLES L. MARTIN, M.D., AND FRED T. ROGERS, PH.D.

From the Laboratories of Baylor Medical School

DALLAS, TEXAS

TO the student it must be evident that the recent rapid strides of roentgen-ray therapy have uncovered many long lanes of research that deserve careful and painstaking investigation. It is to be regretted that the field of biological research is not advancing as rapidly as that of electrophysics, since all rational *x*-ray therapy must be based on our knowledge of biological reactions to radiation.

At the present writing, it seems that no one portion of the body offers more of interest from the *x*-ray point of view than the gastrointestinal tract. There can be little doubt that the intestine plays a definite rôle in at least one form of roentgen-ray toxemia. Denis, Martin and Aldrich[1] described, in 1920, the results obtained following the regional radiation of animals. It was pointed out that a certain dose of *x*-rays would produce the death of a rabbit only when delivered over some portion of the intestinal tract. When this same dose was administered to the chest or to the hind legs, no noticeable reaction was observed. Warren and Whipple[2] have repeated these experiments, using dogs instead of rabbits, and have reported similar results. They have also made a careful histological study of the intestine falling within the region of exposure, and report that many areas show a complete absence of epithelium. These workers state: "The epithelium of the small intestine from the pylorus to the ileocecal valve is remarkably sensitive to the roentgen rays. . . . We may infer that the *x*-rays may produce sublethal injury to this intestinal epithelium which may be responsible for a variety of disturbances associated with gastrointestinal symptoms." The same investigators call attention to the similarity of the symptoms of roentgen-ray toxemia to those observed in experimental intestinal obstruction.

Dragstedt, Moorhead and Burcky,[3] after studying the rapid death of dogs with isolated artificially prepared closed intestinal loops, make the following statements: "Thus it is probable that bacteria alone, or in connection with the contents of the lumen of the intestine, do not give rise to the toxemia of obstruction when they are separated from the blood by the cells of the intestinal mucosa. However, a combination of these two factors (necrotic tissue plus putrefactive intestinal bacteria) rapidly gives rise to fatal toxemia."

The practical significance of intestinal reactions was rather forcefully brought to our attention a few months ago when one of our patients developed a bloody diarrhea, following the application of a heavy dose of rays to the lower abdomen. A nodule about 2 in. in diameter had appeared in the abdominal wall several months after a hysterectomy for carcinoma of the fundus of the uterus. A dose of 600 ma. min. at a target-skin distance of 12 in. was delivered to an area of skin 8 in. square, with a sphere gap reading of 140 kv. A filter consisting of ½ mm. of copper and 1 mm. of aluminum was used. The skin reaction was rather severe, and was soon followed by the passage of blood per rectum, which continued for several months. The patient seems to have suffered no permanent inconvenience from this occurrence.

However, more serious results have been reported in the foreign literature. Beclere,[4] in discussing the treatment of a case of carcinoma of the cervix, states that a condition like dysentery was set up with bloody stools, colonic perforation and stenoses. Fischer[5] describes 3 cases of fatal necrosis of the intestine following the use of deep therapy in the treatment of abdominal tumors. He emphasizes the fact that the intestine is easily injured where the abdomen is exposed to crossfiring.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., September 12–16, 1922.

The above observations justify a careful study of the sensitiveness of the intestine to radiation. Different authors have estimated the carcinoma dose as 100 to 140 per cent of the erythema dose. Some data should be obtained relative to the effect of the erythema dose and various fractions thereof on the intestinal tract, before an attempt is made to treat tumors situated in the abdominal cavity by deep radiation. It is true that many writers claim that they are delivering as high as 110 per cent of the erythema dose into the abdominal cavity without mishap, but it must be remembered that this measurement is based entirely on physical instruments and calculations, and not on the actual reaction of the living cells in the depths of the tissues.

In an effort to throw some light on this subject, a series of experiments was mapped out in which no physical measuring devices were necessary. Animals were operated upon under ether in the *x*-ray laboratory, and loops of intestine laid out on the abdominal wall, so that the intestine and the skin received the same quantity of *x*-rays. The animals were then closed up and allowed to recover from the operation. Obviously, it was quite easy to read the dose of rays received by the exposed intestinal loop in terms of the skin erythema dose at the end of ten to fourteen days.

In deciding upon a technique for this work, a parallel gap of 5 in. was adopted, and no filters were used except a thick piece of paper, which kept the heat and light from the target from striking the exposed viscera. It might be the feeling of some that only short wave-lengths should be used in dealing with deep therapy problems. It seems, however, that the reaction of living cells is dependent only on the quantity of rays absorbed, regardless of the wave-lengths. Thus Kroenig and Friedrich[6] state: "Within the limits of hardness of the radiations investigated, the intensity of the biologic action is independent of the hardness of the rays; the intensity of the biologic action is only dependent on the radiation energy absorbed." Heavily filtered doses were impractical, because it would have been difficult to keep animals in good condition after leaving the abdomen open for two

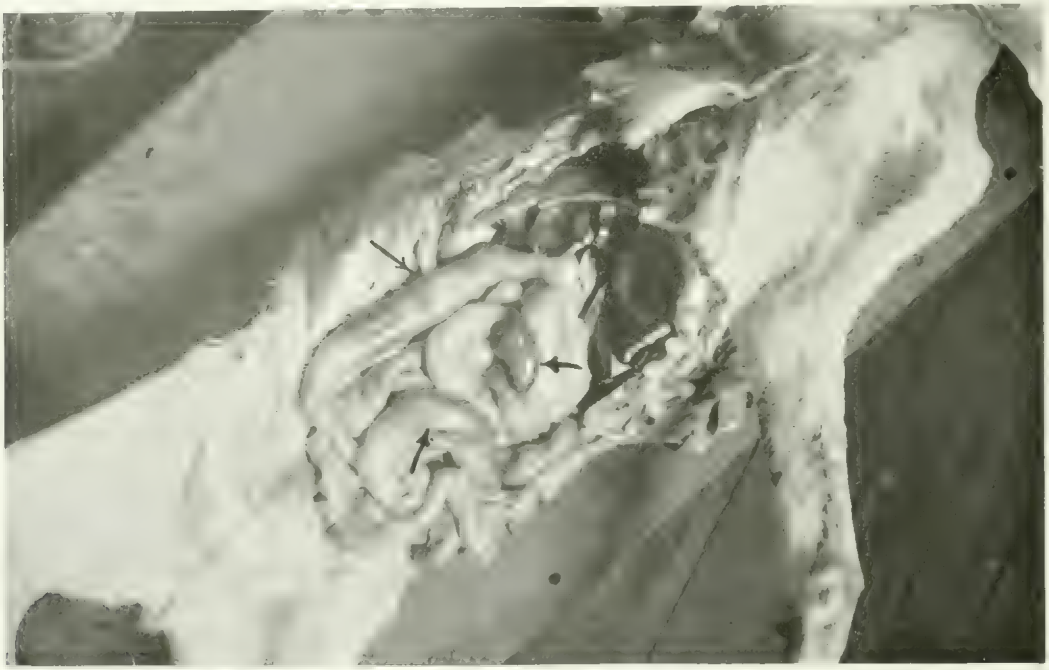


FIG. 1. Pathological loops of intestine found in animal that died four days after receiving 200 ma. min. over each flank.

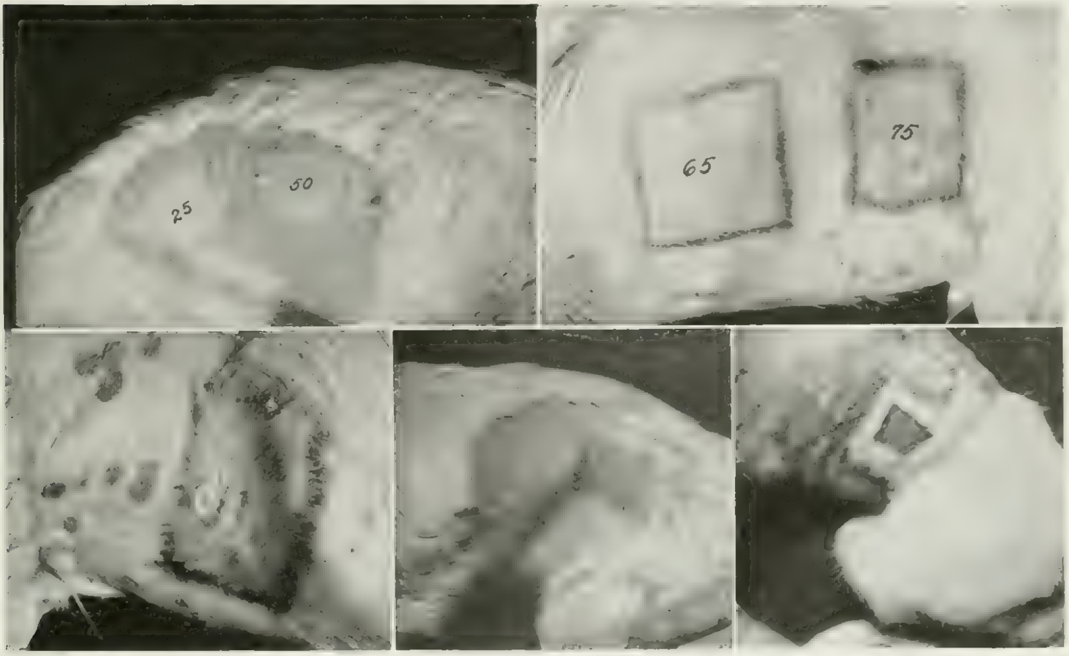
or three hours, and a skin erythema could hardly have been obtained from a shorter exposure.

The spark-gap was determined by a point to point measurement at the beginning of the investigation, and the reading of the low tension voltmeter observed. At all subsequent experiments, the machine was set to give the same voltmeter reading, regardless of what the point gap might be. This gap measurement was found to vary from 5 to 5¼ in. on different days. A sphere-gap used at the beginning of the work showed a definite sparking over when adjusted to a reading of 75 peak kv. with the machine running at the setting just described.

All experiments were performed with a secondary current of 10 ma. read on 3 milliammeters of different makes connected in series. These instruments checked each other within ¼ ma. at this reading. A target-skin distance of 10 in. was used throughout the investigation.

In all the published work coming to our attention in which fatal doses have been delivered to animals, a parallel gap of 8 or 9 in. has been used. In order to compare the effect of a 5 in. back-up, a dog of medium size was given a dose of 200 ma. min. over each flank. Areas 3½ in. square were used, and the remainder of the dog's body was shielded with lead foil. On the third day, this animal refused food and developed a diarrhea. On the morning of the fifth day it was found dead in its cage. Autopsy revealed the condition shown in Figure 1. Several loops of small bowel showed dilatation and a smoothing out of the normal convolutions. There was also a marked hyperemia made out in the affected loops, and, in places, the intestinal wall showed definite thinning. The worst lesions were in the duodenum. This pathological picture is practically the same as that described by Warren and Whipple in experiments in which the higher voltages were used. A 5 in. gap was therefore adopted as suitable for the work in hand.

It was, of course, necessary to determine the erythema dose as accurately as possible before beginning the operative work. Unfortunately, the dog's skin, as well as that of all other experimental animals, is very



25 and 50 ma. min.
65 and 75 ma. min.
85 ma. min.
100 ma. min.
150 ma. min.

FIG. 2. Photographs of the skin reactions observed following the administration of various doses. Where the reactions are absent or faint, the exposed square is outlined with a skin pencil.

resistant to radiation. Areas 2½ in. square were marked off on the abdomens of three different white dogs, and doses of 25, 50, 65, 75, 85, 100 and 150 ma. min. administered. The skin of the exposed area was shaved in each instance. Figure 2 shows the reactions obtained.

The erythema, where it appeared, was always visible by the eleventh day. A very slight discoloration was observed over the area receiving 65 ma. min., but the area receiving 75 ma. min. was the first one in the ascending scale to show an unmistakable reaction. Seventy-five ma. min. was therefore accepted as the minimum erythema dose for the skin of a dog under the conditions stated above. This dose is more than three times the "erythema dose" for the human skin. One hundred ma. min. gave a reaction which approached the one commonly used in therapeutic work. The skin turned red in eleven days and then slowly became brown. At the end of a month, desquamation was in progress. There was no vesiculation or ulceration at any time. One hundred and fifty ma. min., which may be considered as double the minimum erythema dose, slowly developed a shallow ulceration, which was surrounded by a broad band of alopecia. At the end of six weeks the ulcerated area was crusted over and much contracted, and was beginning to heal. The burn produced by this dose was not of the serious "incurable" type, and might be taken to represent the "erythema dose" of the degree described by some of the most radical workers. It was deemed necessary to study a wide range of skin reactions, because deep therapists differ widely in their conceptions of the "erythema dose."

Since the mucosa has been shown to be the most sensitive portion of the intestinal tube, the question of the filtering effect of the muscular layers immediately arose. In other words, it was important to determine whether the dose delivered to the peritoneal surface of the intestine differed materially from that delivered to the mucosa. In studying this point, two squares measuring 3 in. on a side were marked off on the flank of a large brindle dog, and at the time of exposure a freshly-opened piece of small intestine from another animal was laid across the mid-portion of each area. Doses of 100 and 150 ma. min. were applied to the two areas. At the end of eleven days, there was a definite reaction over each square, but there was no detectible difference made out between the erythema of the skin that had been covered by intestine, and that which had not been covered. Figure 3 illustrates the results obtained.

From these observations it seems fair to assume that the filtering effect of the intestinal wall is too small to be taken into account, and that the dose delivered to the skin in the following experiments is practically the same as that delivered to the intestinal mucosa.

All the dogs submitted to operation received the same preparation. The skin of the operative field was shaved and cleansed with soap and water and ¼ gr. of morphia and 1/100 gr. of atropin sulphate were given subcutaneously about three hours before beginning the procedure. The medication provoked active emesis, defecation and urination, and was of great value in that the intestines were almost completely emptied. An operating table was set up in the *x*-ray laboratory, so that there was little delay in carrying out the whole procedure. Ether anesthesia was used for each experiment, and all precautions were taken to provide the most perfect asepsis possible. No iodine, bichloride of mercury or other irritants were used. The skin was sterilized with 70 per cent alcohol. This eliminates any skin sensitization.

In our laboratory, the "erythema dose" for the human skin as used in the treatment of cutaneous malignancy is taken to be 25 ma. min. for the settings adopted for this investigation. It was, therefore, thought advisable to study first the effect of this dose on the dog's intestine. The abdomen of a medium-sized female dog was opened. A sterile shield of lead foil was placed over the dog's body, so that a square hole measuring 2½ in. on a side lay over the incision. A loop of ileum measuring 12¼ in. in length was brought up through the hole in the shield and spread out over a layer of gauze moistened in warm normal salt solution. A second thin layer of moist gauze was placed over the loop, to prevent drying. The edges of the wound were clipped together temporarily, so that there was a small area of skin directly exposed in the upper half of the hole in the shield. The appearance of the operative field is shown in Figure 4. The *x*-ray tube was swung over the intestinal loop and a dose of 25 ma. min. administered.

Following this procedure, sutures were placed in the mesentery at the ends of the exposed loop, as markers, the intestine was dropped back into the abdominal cavity and the incision closed. The abdomen was bandaged and the animal was placed in a clean cage. After two days the bandages were removed. At the end of three weeks the skin showed no evidence of a reaction and the dog appeared to be in excellent condition. Autopsy was performed. The exposed loop showed no gross abnormality, either on the serous surface or in the mucosa. The findings are illustrated in Figure 5. The human "erythema dose" is therefore too small to be of value in these experiments.

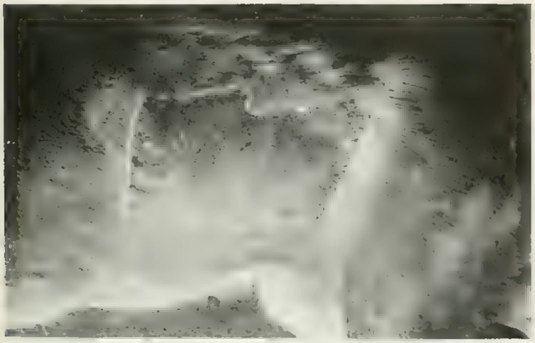


Fig. 3. Areas over parts of which strips of fresh intestine were placed before exposure. Note the uniformity of the reaction.

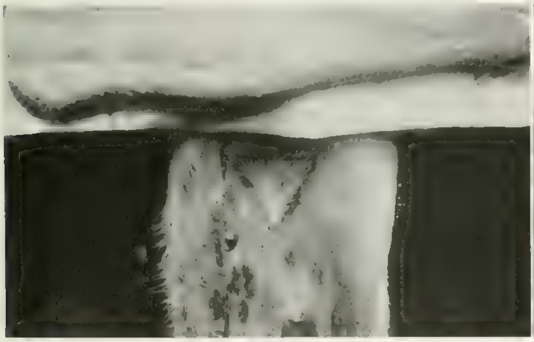


Fig. 5. Open strip of intestine and area of skin which received 25 ma. min. There is no abnormality visible.

Seventy-five ma. min., the minimum erythema dose, was selected for the next experiment. A medium-sized dog was subjected to the same operative procedure as that described above, except that the loop of intestine exposed measured $17\frac{1}{2}$ in. in length, and included the lower jejunum and upper ileum. The dog made an excellent recovery. A slight stitch infection caused the skin about the wound to remain moist during the first ten days. A faint erythema was observed on the eighth day over the exposed skin area. On the twelfth day, this region showed a deep red color. On the seventeenth day,

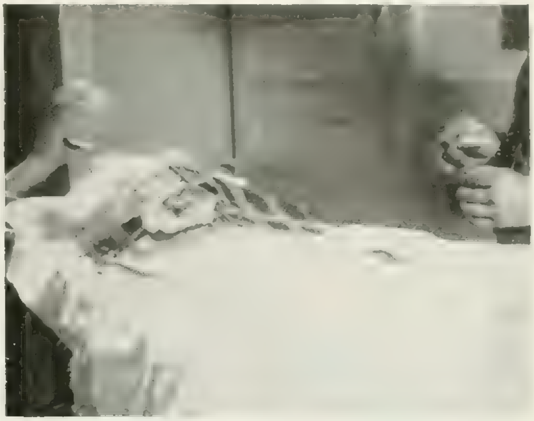


Fig. 4. The operative field just after the intestinal loop was drawn through the lead foil shield. A thin piece of wet gauze was placed over the intestine before radiation was begun.

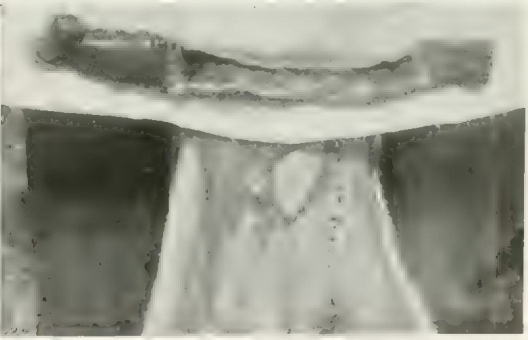


Fig. 6. Exposed strip of small intestine and skin area which received 75 ma. min., the minimum erythema dose for a dog.

the red color was observed to be fading, and on the twentieth day, no sign of the skin reaction could be made out, except an alopecia over the exposed area. At the end of three weeks autopsy was performed. The dog was very active and appeared to be in the best of health during the time of observation. No vomiting or diarrhea had been observed.

On opening the abdomen, the exposed loop could be identified by the smoothing out of the circular convolutions observed in the normal intestine, and also by a hyperemia due to the injection of the subserous vessels. However, the most striking change was the marked shortening of the loop. The distance between the markers was just 6¼ in., whereas at the time of exposure, this distance measured 17¼ in. The contraction of the skin when subjected to an erythema dose was described by one of us in a previous paper.[7] Contraction appears to be an outstanding feature of roentgen-ray reactions.

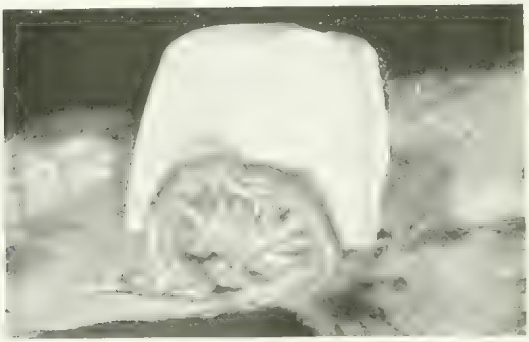


FIG. 7. External appearance of loop of intestine receiving 100 ma. min. three weeks after exposure.

When the loop was laid open, a pathological picture of such severity was revealed that it seemed hard to believe that this animal had been symptom-free. With the exception of an elongated patch near the mid-portion of the exposed region, the velvety appearance produced by the villi was absent. The inner surface of the intestine was smooth and dark red in color. Most of the epithelial layer had disappeared in the discolored areas. The limits of the roentgen-ray effect were sharply demarcated at the ends of the loop. There was no evidence of hemorrhage into the lumen of the bowel, which showed normally colored contents. The diameter of the lumen of the intestine was diminished. The appearance of the exposed bowel and the excellent condition of the skin of the exposed area (marked off with a skin pencil) are shown in Figure 6. Obviously, the minimum dose producing erythema of the dog skin produces considerable damage to the small intestine of the animal.

A small white dog was next subjected to a similar procedure, except that a loop of small intestine measuring 5 in. in length was subjected to a dose of 100 ma. min. The animal recovered promptly, and remained in perfect condition without showing any symptoms, for three weeks. At the end of that time an autopsy was performed. The exposed loop could be identified because of its contraction, hyperemia and smooth appearance. It measured just 2½ in. in length and showed considerable subserous injection of blood-vessels. The external appearance of the loop is shown in Figure 7. When the intestine was opened, the greater portion of the epithelium in the exposed area was found to be absent, and that which remained was in a necrotic condition. The denuded areas were quite smooth, and dark red

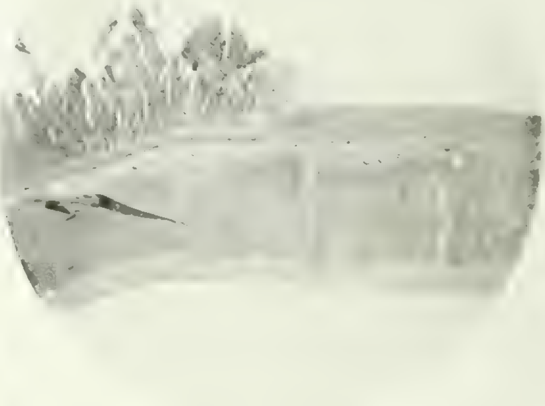


FIG. 8. Low-power view of longitudinal section of intestinal wall from exposed loop shown in Figure 7. Note the complete desquamation of epithelium over the involved region.

in color. The margins of the involved region were very sharply defined.

Figure 8 shows a very low-power view of a longitudinal microscopic section extending from the normal into the abnormal intestine. The abruptness with which the mucosa stops is strikingly shown. The submucosa is considerably thickened, and shows much white-cell infiltration. The muscle bundles in the wall of the intestine show vacuolization, and are therefore also damaged by the exposure. There are no definite changes made out in the blood-vessels.

A large pregnant bulldog was selected for the application of the dose of 150 ma. min. Ten and one-half inches of the small intestine were exposed. The upper end of the uterus lay within the field of exposure. At the end of ten days, the animal appeared to be in excellent condition, and there was a definite erythema over the small portion of skin which was used as an indicator. At the end of two weeks, the animal showed no symptoms whatsoever, but autopsy was decided upon.

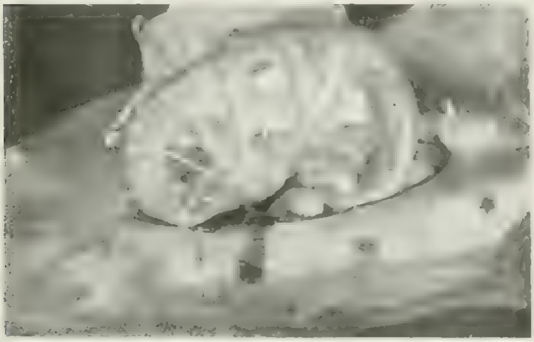


Fig. 9. External appearance of intestinal loop two weeks after receiving a dose of 150 ma. min. Note the skin control just below the incision. The smoothing out of the involved region is the most striking change.

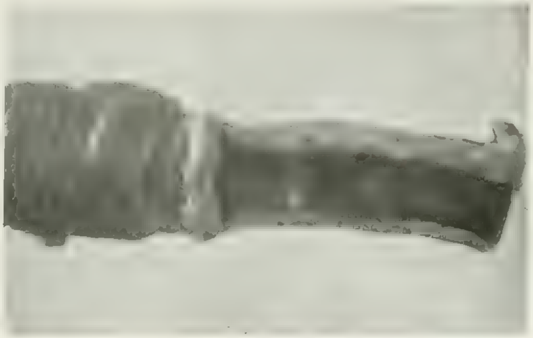


Fig. 10. An opened portion of the loop shown in Figure 9. The complete loss of epithelium and the contraction of the involved area are well shown.

The skin area showed a shallow ulceration at that time. On opening the abdomen, the loop could be identified by its smooth appearance and by the blood-vessel injection, as in the previous experiments. It measured 5 in. in length. On opening the intestinal tube, the exposed region was found to possess a smooth red inner surface, over which there was no trace of an epithelial covering. The striking appearance is shown in Figure 10. The decreased diameter of the lumen can be easily made out. There was no tendency toward abortion during the two weeks of observation.

The most puzzling feature of all these experiments was the good condition of the animals, which persisted up to the time of autopsy. The work of Warren and Whipple had led us to believe that *x*-ray damage to the intestinal epithelium would cause death within four days. It was thought wise to repeat the above experiment and keep the animal as long as possible, in order to study the end results. A medium-sized black dog was selected and a dose of 150 ma. min. administered to a loop of small intestine $9\frac{1}{4}$ in. long. There were no symptoms at the end of two weeks, but at the end of sixteen days the animal refused food and began to lose weight and to go down hill rapidly. At the end of nineteen days, the dog's condition was so bad that autopsy was decided upon. The findings were practically the same as those described above, for a dose of 150 ma. min. The loop measured 4 in. in length and showed complete desquamation of epithelium. The emaciated condition of the animal is shown in Figure 11, and the appearance of the intestinal loop in Figure 12.

These findings seem to indicate that double the minimum erythema dose is rapidly fatal. It is to be regretted that lack of time prevented our observing the effects of the smaller doses over longer periods. It seems fair to assume that the milder reactions would finally produce a stenosis, even though no toxic symptoms appeared.

These experiments bring out certain points of interest. For instance, it seems evident that it would be impossible to deliver a minimum erythema dose into the abdomen of a dog without injuring the intestine. Unfortunately, the experiments cannot be directly applied to the human body, since there is no way of comparing the sensitiveness of the human intestine with that of the dog. If all the portions of the dog's body possess the same relative degree of sensitiveness to the rays that has been observed in the human body, then these animal experiments seem to prove that no erythema dose can be delivered into the abdomen without producing intestinal damage. They also suggest that a certain degree of damage to the small intestine is compatible with life. Evidence of a more convincing nature can be obtained at the autopsy table. Let us suggest that the intestine be carefully examined, where cases that have received ultra deep therapy over the abdomen come to autopsy. It is not sufficient to study the serous surfaces, since the maximum damage occurs in the mucosa. All the loops in the exposed region should be opened.

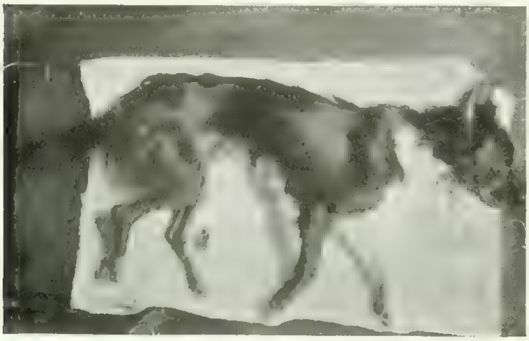


Fig. 11. Great emaciation of animal nineteen days after receiving 150 ma. min. over a single loop of small intestine. This condition resembles the roentgen cachexia observed clinically.

The term "roentgen cachexia" has been appearing in the foreign literature for some time. It seems that certain patients become much emaciated after being subjected to heavy doses of *x*-rays as administered in Europe. After studying the emaciation produced in guinea pigs, rabbits and dogs by heavy doses of rays delivered over the abdomen, we have been led to conjecture that possibly the "roentgen cachexia" observed in human beings may have a similar origin. The causes of this cachexia are uncertain. Is it due to a toxemia, to diminished food intake, or to diminished digestive power secondary to the intestinal lesions? Perhaps other factors are involved. Further analytical work is required to answer these questions.

We wish to acknowledge the valuable assistance of Dr. B. F. Hambleton in the operative work and of Dr. G. C. Caldwell in the post-mortem studies incident to the preparation of this paper.

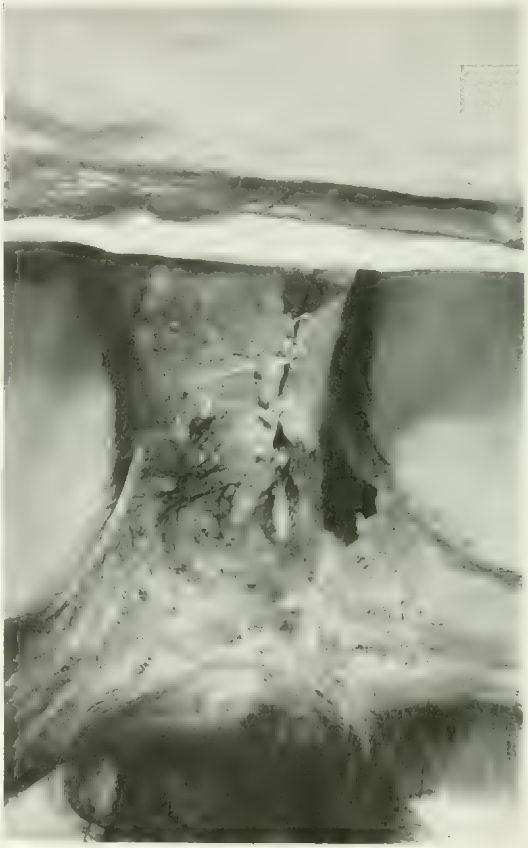


Fig. 12. Opened section of exposed loop of intestine from dog shown in Figure 11. The control skin reaction is seen just below the folded towel. The desquamation of epithelium over the involved area is complete.

SUMMARY

1. The skin of the dog is much more resistant to roentgen rays than is the skin of man.

2. The minimum erythema dose for the dog's skin when applied directly to the dog's intestine produces hyperemia, marked contraction in all directions and destruction and desquamation of the mucosa.

3. Bloody diarrhea, ulceration, perforation and stenoses occurring in patients subjected to ultra deep therapy for abdominal tumors may be due to direct intestinal injury.

4. Roentgen cachexia is possibly due to the same cause.

5. Intestinal damage in dogs, resulting from direct radiation, does not always produce an early death.

BIBLIOGRAPHY

1. Denis, W., and Martin, C. L. *Am. J. M. Sc.*, Oct., 1920, clx, No. 4, 555.
2. Warren, S. L. and Whipple, G. H. *J. Exper. M.*, Feb., 1922, xxxv, No. 2, 187.
3. Dragstedt, L. R., Moorhead, James J., and Burcky, F. W. *J. Exper. M.*, xxv, 421–439.
4. Béclère, A. *Presse méd.*, Nov. 23, 1921.
5. Fischer, B. *Strahlentherapie*, Feb. 1, 1922, xiii, 333.
6. Kroenig and Friedrich. Radiation Therapy, 1922,
7. Martin, Charles L. Am. J. Roentgenol., vi, No. 4. 180–187.

IMPORTANT POINTS IN THE TECHNIQUE OF ROENTGENOLOGICAL EXAMINATIONS OF THE URINARY TRACT*

BY BERNARD H. NICHOLS, M.D.

Cleveland Clinic

CLEVELAND, OHIO

During the past twenty years, the development of new methods and instruments has led to an increasing accuracy in the diagnosis of diseases of the genitourinary tract. The greatest single achievement was perhaps the invention of the cystoscope, by means of which pathological conditions of the bladder can be visualized. Catheterization of the ureters followed the introduction of the cystoscope, and in 1906, Volker and Von Lichtenberg reported the first successful injection of an opaque substance into the ureter and kidney pelvis, thus making possible the development of one of the most valuable diagnostic aids in identifying pathological conditions of the genitourinary tract.

The next great advance we point to with pride because it was developed by our president. In 1919, Dr. Stewart and Dr. Stein perfected the technique and introduced pneumoperitoneal examinations in this country. This was an important advance. By this measure, accurate visualization of the kidneys may usually be made, and their size, shape and position determined. It is also of the utmost value in diagnosing tumor of the kidney, particularly when we are in doubt as to the origin of a tumor mass in the region of the kidney.

Dr. Carelli of Buenos Aires further developed the technique of gas inflation, and by his method of perirenal injection the kidney may be well visualized. This is of particular value in cases in which we wish to show the upper pole of the kidney and the suprarenal glands.

When a case is referred to the roentgenological laboratory for examination, diagnostic plates should be made of the entire genitourinary tract. We often have patients referred to us for confirmation of a previous diagnosis of calculus in one or the other ureter. Often such a patient has with him roentgenograms showing the suspected shadow in the ureteral area. These may be of good diagnostic quality, and we may make another of this same area which corresponds to those brought by the patient (Fig. 1). Nevertheless, these plates do not give sufficient data on which to base a diagnosis.

A complete examination of the entire genitourinary tract should be made in every case. Often another calculus may be found in the kidney on the same side as the ureteral calculus (Fig. 2, *a* and *b*); or one may be present on the opposite side. Such information is of the utmost importance to the surgeon before an operative procedure is undertaken. The presence, size and shape of both kidneys should be determined in every case which presents symptoms indicating a possible pathological condition in the genitourinary tract. The outline of the liver should be definitely determined, as an enlarged liver or an elongation of a single lobe may easily be mistaken for a movable kidney (Fig. 3).

---

*Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922.

A careful and complete clinical history, with a microscopical examination of the urine should be made in every case, as this will often guide us to the proper technical procedure whereby we may reach a correct diagnosis. In the absence of calculus, a history of pain, together with its character and duration, may indicate a floating kidney, a tumor, or an intermittent hydronephrosis, which is often overlooked, and the patient submitted to operation for chronic appendicitis or a gall-bladder lesion, without resultant relief. Not only can hydronephrosis be definitely diagnosed by pyelography, but often the cause also can be determined, and therefore failure to diagnose or eliminate this condition demonstrates a poor technique on the part of the roentgenologist.

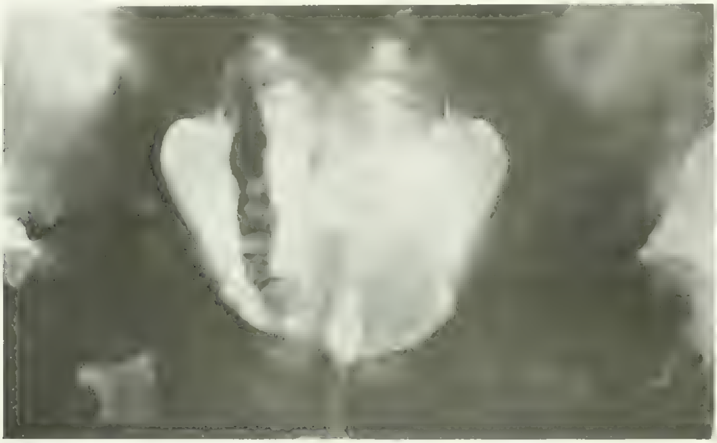


Fig. 1. Calculi in the left ureter.

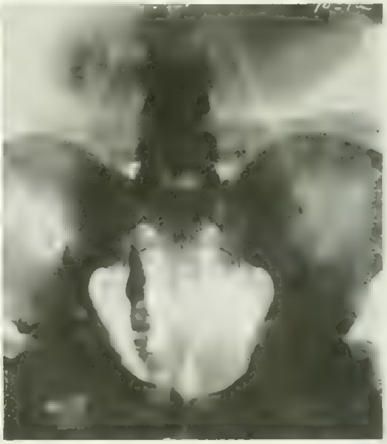


Fig. 2a. Calculi in the ureter and in the kidney on the same side.

Bacilluria and the type of bacteria present in the urine, or hematuria, or a combination of these clinical findings are often the factors which determine what technique should be followed in further efforts to determine the nature of the pathological condition.

All these examinations of the kidney, the ureter and the bladder are best carried out in collaboration with a competent urologist. The point which I wish to emphasize is the importance of a careful analysis of the clinical and laboratory findings as a guide to our technical procedure; a report of negative findings from the roentgenologist often gives the referring physician or surgeon a wrong impression, with the result that he may make no further investigation of the case. It is, therefore, evident that the roentgenologist should eliminate the possibility of any pathological condition which is demonstrable by a roentgenological examination, and that, in each case, he select a suitable technique to accomplish this purpose.

Our present technique for the first examination of the genitourinary tract is as follows: The patient is examined without any previous preparation. If a suspicious shadow is found at this first examination, the patient is given a thorough preparation by catharsis followed by an enema, and the second examination is made. Castor oil is not used as a cathartic, as it produces considerable gas in the intestines, which usually interferes with the visualization of the kidneys.

If no shadow is found in the second examination, we can conclude that the one seen at the first examination was an enterolith or some opaque substance in the intestinal tract.

All kidney examinations are made on 14 × 17 duplitized films with double screens, and a Potter-Bucky diaphragm

55 kv. 20 ma. at a distance of 25 in., the time of exposure being governed by the size of the patient. Deep compression by means of an inflated rubber bag is always used, and the tube remains over the center of the diaphragm without tilting. Two films are used; on one, the crest of the ilium is placed 1 in. above the center of the film (Fig. 4), thus giving a complete view of the bladder and ureters; on the other, the crest of the ilium is placed 1 in. below the center of the film thus showing both kidneys and both ureters (Fig. 5). This same technique is used in all kidney examinations.

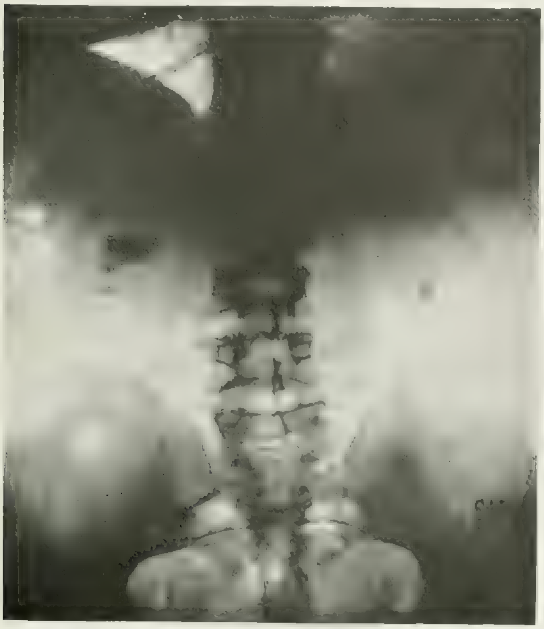


Fig. 2*b*. Calculi in the left kidney and calculus in the right kidney.

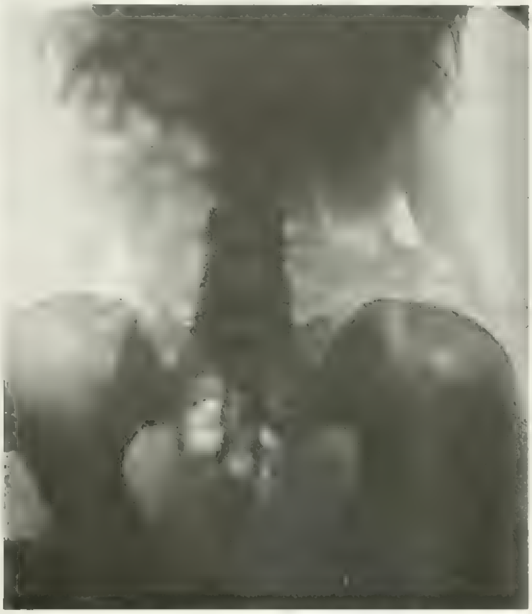


Fig. 3. Elongated liver lobe which, on palpation, feels like a displaced kidney.

We are trying a curved cassette which brings the kidney close to the film, and also brings the portion of the film which is under the kidney closer to the tube than that portion which is under the spine, thus giving the kidney relatively more exposure than the spine. We are experimenting also with a new type of film coating which approaches a portrait emulsion and gives details of the soft shadows which are brought out still more by developing the films in solutions which contain a relatively small proportion of bromides.

We wish here to express our appreciation of Dr. Potter's perfection of the Bucky diaphragm, which has made possible the development of this technique.

If a shadow is seen in the kidney area, which we believe to be a calculus, it should be determined whether it lies in the kidney pelvis or in the cortical substance of the kidney. This may necessitate the making of a pyelogram. If the calculus is outside of the kidney pelvis, it will be easily seen; if within the kidney pelvis, it will probably be obscured by the opaque injection. This information is important to the surgeon, as he will be guided in his operative procedure by approaching the kidney at the most advantageous point for removal of the calculus.

A suspicious shadow in the ureteral area of either side should be checked by catheterization of the ureters with an opaque catheter, and films made at two different angles, to determine the proximity of the shadow to the catheter which represents the lumen of the ureter.

I wish to emphasize the importance of the technique in this particular type of case. Usually, if the shadow is found to be in contact with the catheter in each of

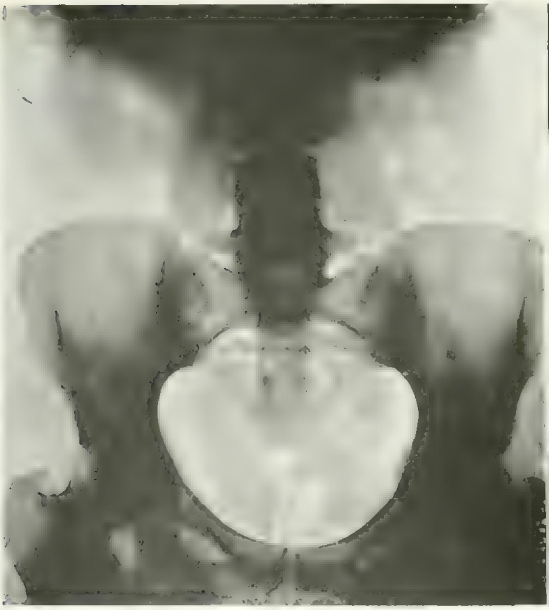


Fig. 4. Position of the film with relation to the crests of the ilia for examination of the bladder and ureter.

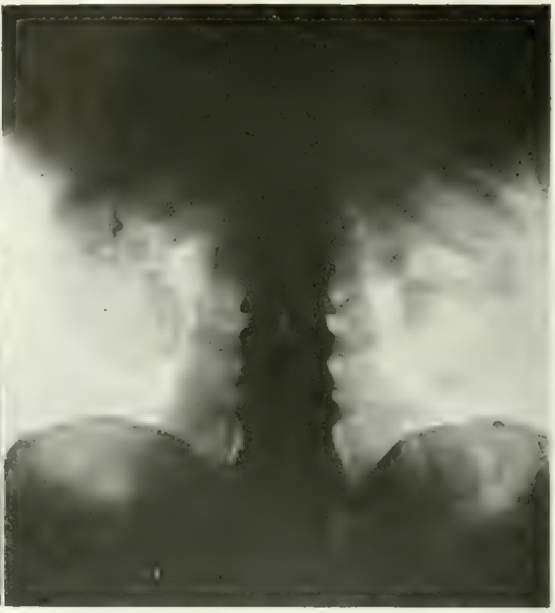


Fig. 5. Position of the film with relation to the crests of the ilia for examination of both kidneys and ureters —polycystic kidneys.

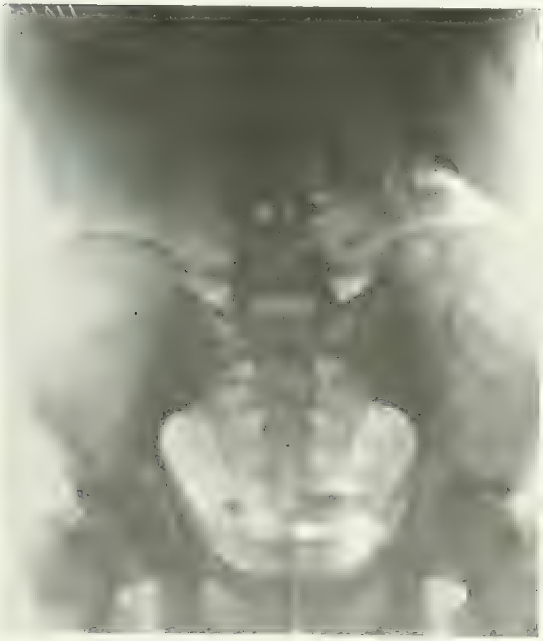


Fig. 6*a*. Suspicious shadow in the lower left ureter.

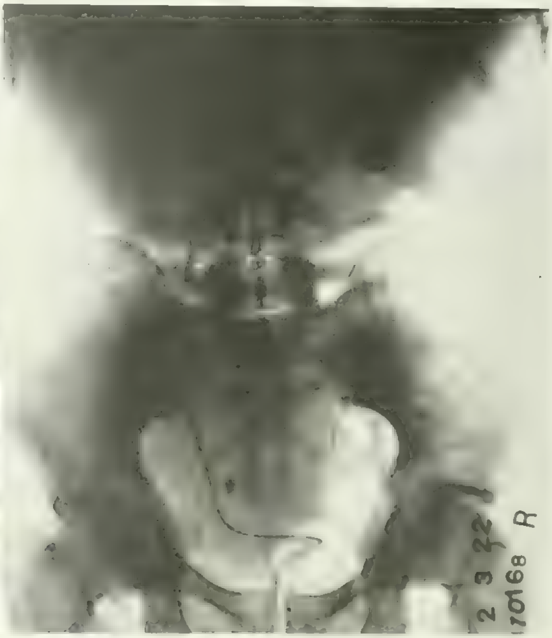


Fig. 6*b*. Catheter in place showing the suspicious shadow apparently outside of the ureter. Same case as shown in Figure 6*a*.

two positions, we feel reasonably sure that the presence of a ureteral stone is indicated. In the case of a small calcified gland below the ureter, one anterior posterior plate of the catheterized ureter may show a shadow directly in contact with the catheter. Another exposure giving a marked oblique or lateral view, however, may disclose a considerable space intervening between the shadow and the catheter, a finding which will usually rule out a calculus. But even a second plate is not sufficient in all cases. Frequently, particularly in the case of a large calculus, the ureter becomes dilated from overdistention due to obstruction. This distention may be enormous, so that the ureter may measure more than an inch in diameter. With this type of case, both the catheter and calculus may be in the ureter, with a considerable distance between them (Fig. 6, *a* and *b*). With a problem of this kind, a ureterogram should be made which will give the exact size of the lumen of the ureter, with the extent of dilatation, and usually the point of constriction (Fig. 7, *a* and *b*). This method is much more accurate than the waxed-tip catheter, which may be introduced into the dilated ureter, and at no time come into contact with the calculus.

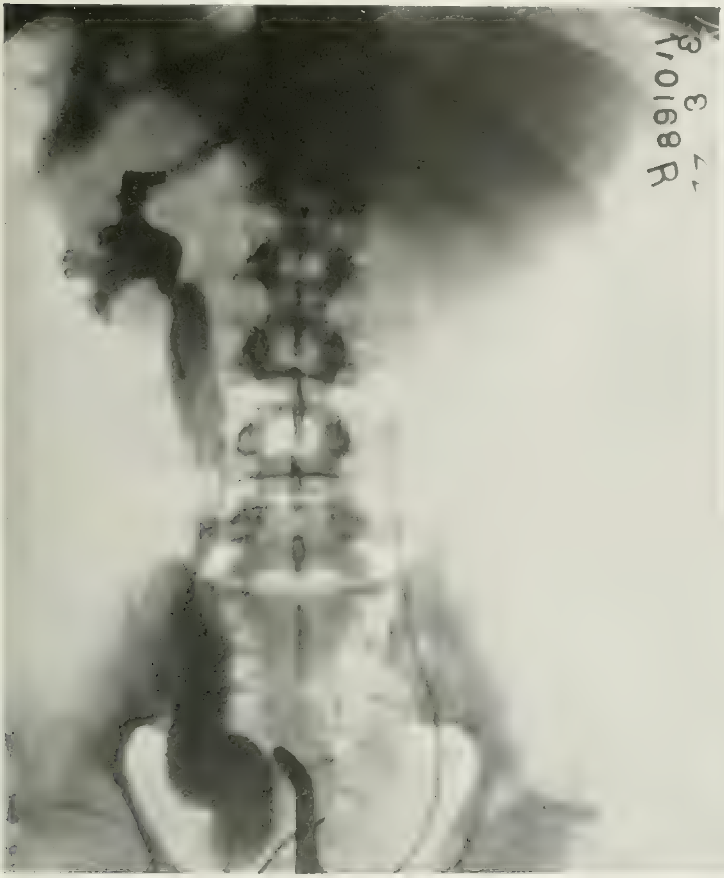


FIG. 7*a*. Injected ureter showing large hydro-ureter. Ureter contains both catheter and calculus. Same case as shown in Figure 6*a*.

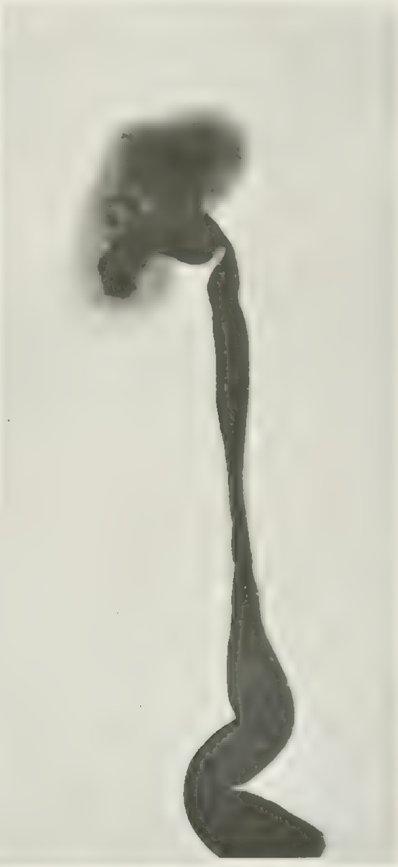


FIG. 7*b*. Injected ureter and kidney, shown in Figure 6*a*, after removal.

When examination of the films shows no evidence of calculus, we should report that the roentgenological findings are negative to calculus; but to this report we should add the statement that in a small per cent of cases, calculi may be present in the ureter or kidney which will not be seen on the roentgenograms. We believe that in some cases, this lack of visibility is due to the small size of the calculus, and in other instances, to their chemical composition. A review of a recent series of 54 cases which were operated upon by Dr. W. E. Lower shows that in one case—or 1.8 per cent—the calculus did not show on the roentgenogram.

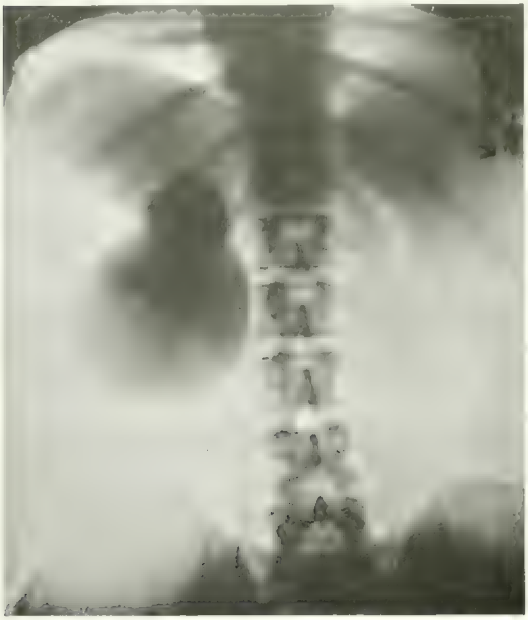


Fig. 8*a*. Hydronephrosis with kinked ureter.

The visibility, size, shape and position of the kidneys should be included in every report, together with spinal lesions or any other pathological condition of adjacent organs which may in any way account for the patient's symptoms.

If all the findings are negative, the clinical symptoms and history should be carefully analysed in consultation with the urologist, and a further study of the case should be made.

Catheterization of the ureter on the side on which the patient complains of pain, and injection of the kidney, pelvis and ureter with sodium iodide solution to determine the possibility of hydronephrosis (Fig. 8, *a*, *b* and *c*), hydro-ureter (Fig. 9), deformed kidney pelvis (Fig. 10, *a* and *b*), obstruction or kinks in the ureter (Fig. 11, *a* and *b*), should be done in cases with suggestive clinical symptoms. We have found a 20 per cent solution of sodium iodide to be the most satisfactory solution for pyelography. In our clinic, all this work is done in the urological section under the supervision of Dr. W. E. Lower. The injections are made by the syringe method, and only one side is injected at a single examination.

Films are made first after the passage of the catheter; then, after injection of the

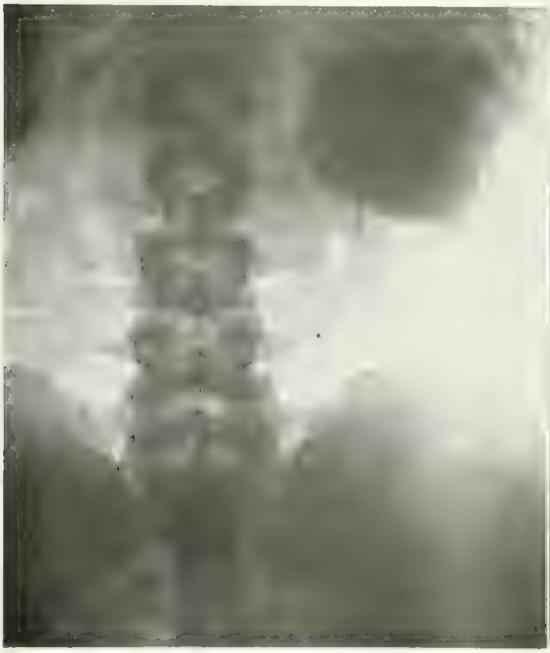


Fig. 8*b*. Hydronephrosis.

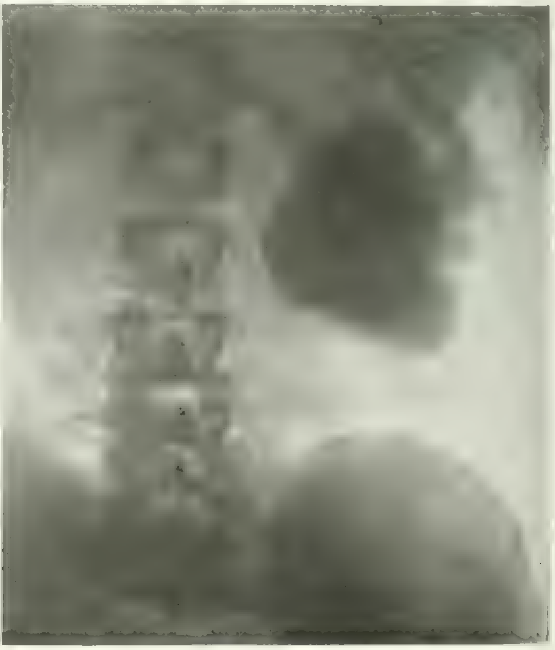


Fig. 8*c*. Hydronephrosis.

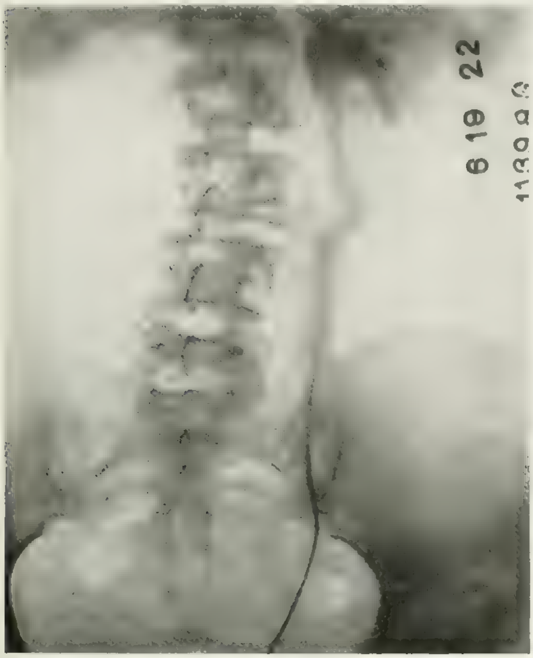


Fig. 9. Hydro-ureter; obstruction in ureter at pelvic brim.

kidney pelvis or ureter, another film is made with the catheter still in place. The catheter is then removed and the patient placed in an upright position and a third film is made. This last position gives a splendid outline of the kidney pelvis and ureter and allows a kinked ureter to assume a position corresponding to that which is present when the patient has an attack.

Many cases, however, have a dilated ureter, or a ureter devoid of its normal musculature; and when the patient is placed in the upright position, the solution immediately flows into the bladder, so that the film will give us no information, but rather appears normal. In such a case, the film with the catheter in place and the patient in the horizontal position will be the one that will be of diagnostic value.

We found that it was necessary to have a practical table on which to carry out this technique (Figs. 12 and 13). We used, as a nucleus, a Young cystoscopic table, to which a tube stand was attached. The top of the table was removed and a Potter-Bucky diaphragm built into the table, the whole being covered by a sheet of aluminum. A 30 ma. radiator type tube is used with a small transformer on the wall. This will deliver a 5 in. spark gap at 20 ma., which is ample for all cases. Deep compression is made by an inflated rubber

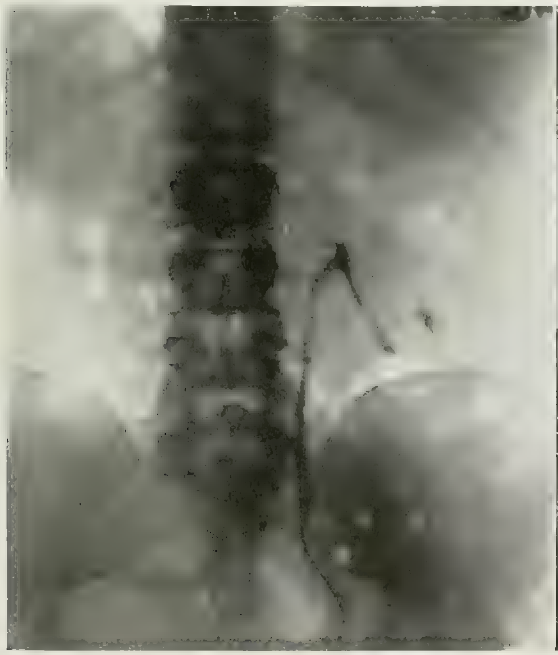


Fig. 10*a*. Deformed kidney pelvis in a case of tumor of the kidney.

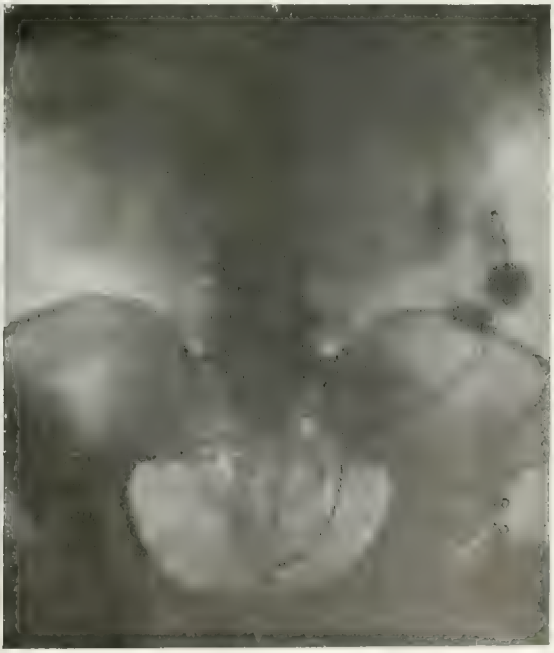


Fig. 10*b*. Deformed kidney pelvis in a case of pyonephrosis.

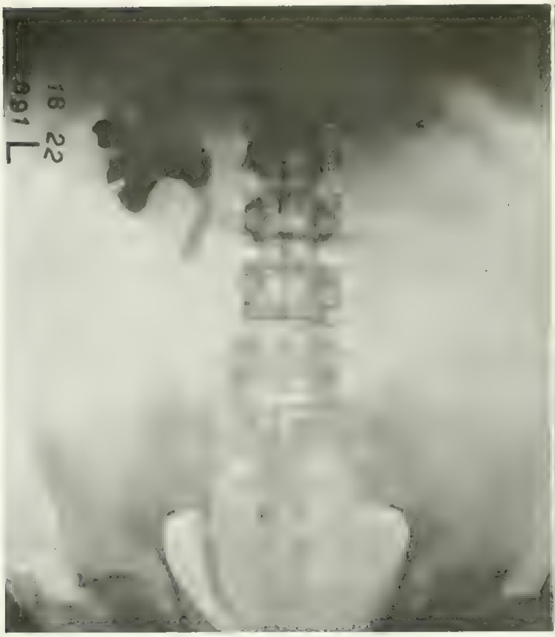


Fig. 11*a*. Kinked ureter with obstruction by calculus at the lower end. The film was made with the patient in the upright position.

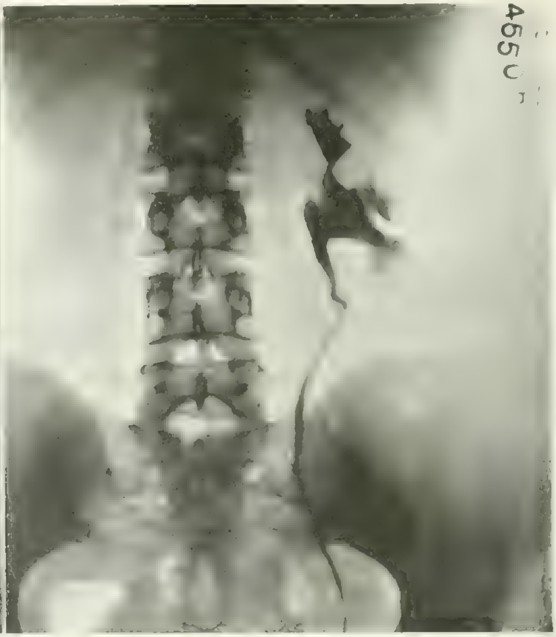


Fig. 11*b*. Kinked ureter.

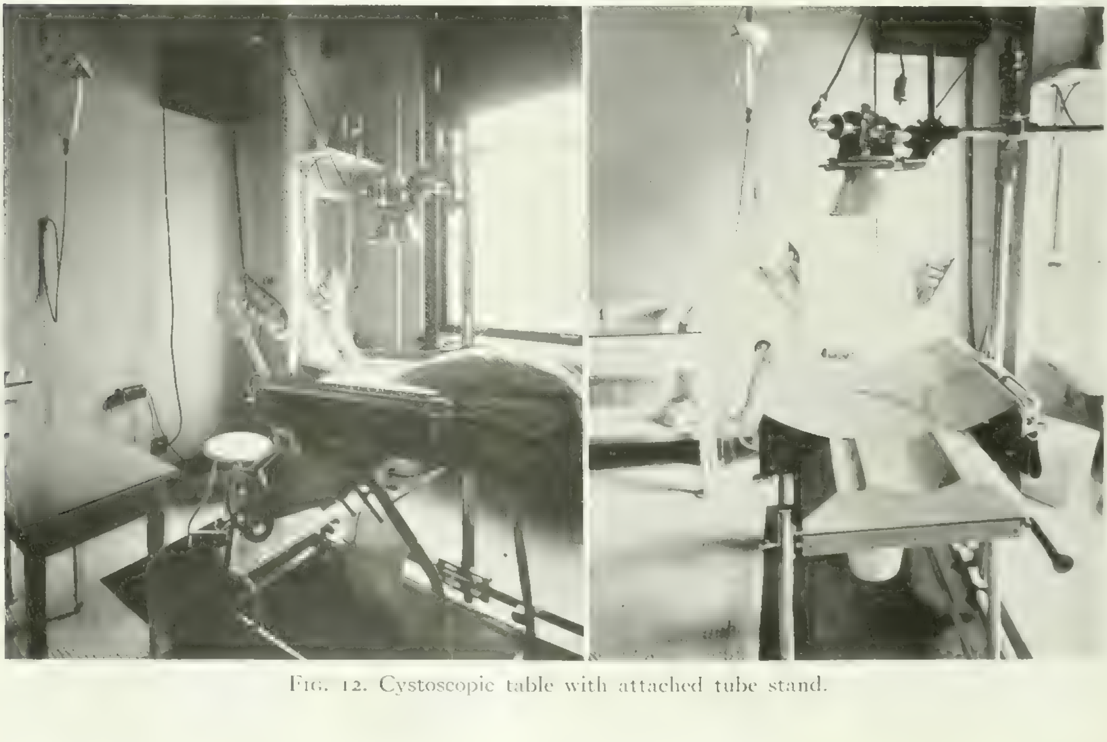


Fig. 12. Cystoscopic table with attached tube stand.

bag and web belt. This table is in the urological section, and is used daily for ordinary cystoscopic examinations.

SUMMARY

The important points in the technique of roentgenological examinations of the urinary tract which I have endeavored to point out are the following:

1. That the entire urinary tract should be examined in all cases.

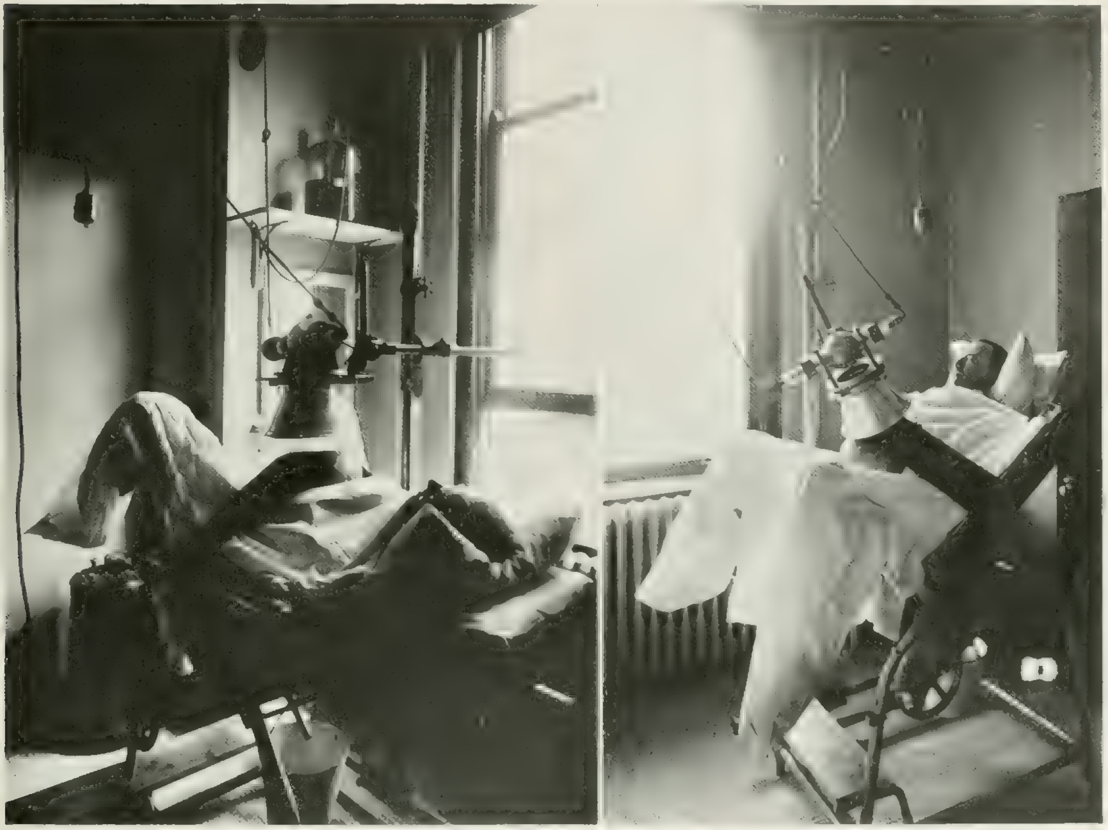


FIG. 13. Cystoscopic table showing its use with patient in two positions.

2. That catheterization of the ureters with an opaque catheter will not determine the character or position of all suspicious shadows in the ureteral area, but further study should be made by means of ureterograms.

3. That in pyelograms made in the upright position, there is the possibility that the solution may pass quickly through a patulous ureter into the bladder; hence, an examination should be made in the horizontal position also.

4. That a convenient and practical table with a Potter-Bucky diaphragm is essential.

DISCUSSION

DR. JACHES. I, for one, am very much indebted to Dr. Nichols for having presented this paper. It seems that discussions on deep therapy, diagnoses of chest conditions, and possibly, also, diagnoses of gastrointestinal tract conditions have occupied us so much that we have forgotten that there is a genitourinary tract. I have seen very few papers presented on the subject lately. Dr. Nichols' paper has covered the subject so fully that I have little to add, and will limit myself to asking questions.

I want to say that a point well taken is the statement at the close of his report that the roentgenological examination does not present evidence of calculus, but what must be borne in mind is that a small percentage of them cannot be demonstrated by the *x*-ray.

By careful urological checkings we have been able to demonstrate, at the Mt. Sinai Hospital, that in the ureter the percentage of error is something like 11 or 12. The Johns Hopkins Hospital percentage has once been reported as high as 25. In bladder cases the percentage is much higher. Fortunately, in bladder cases, the cystoscope is available for determining the presence of calculus.

I did not hear Dr. Nichols speak of some of the sources of error. Lately there have come to my attention two cases. In one, a very prominent roentgenologist made a diagnosis of the presence of calculus which turned out to be a wart on the back of the patient. Fortunately, this was checked up before operation. On the other hand, it sometimes happens that the patient has a wart just in the location of the calculus, and you might be misled into the belief that the shadow which was present was not that of a calculus, but due to that particular wart.

Some years ago, a patient presented himself to me who had a scab in the region of the kidney, due to the breaking of a hot-water bag. He had smeared it very carefully with zinc oxide, and attempts to remove it led to much bleeding. The patient was submitted to the *x*-ray, and I found a shadow in the region of the right kidney pelvis, corresponding in size and shape to that scab. I reported that a shadow was present, but in view of the scab on the back, I would prefer to re-examine the patient after it had come off. For some reason or other, the patient was never *x*-rayed again. Finally the surgeon had the courage to operate, and found a calculus which consisted mainly of uric acid. Now I am not so certain whether it was the calculus or the scab which was shown on the roentgenogram.

There are a few questions I would like to ask. I did not quite hear Dr. Nichols' explanation for making his first examination without preparation of the patient. I find that whenever the patient is not prepared, the whole examination is futile—at least I have not had the courage to make any diagnosis on roentgenograms showing intestinal gas.

Next question: How much does he gain in taking his ureterograms or pyelograms in the upright position, considering the trouble and inconvenience to the patient? In the several attempts we have made, we might have been able to show a kink a little more distinctly, but, nevertheless, a kink in the ureter shows up in the horizontal position.

Dr. Nichols has also shown some films which were taken with the patient in the prone position. This is a very good point. It is really necessary to make roentgenograms in that particular position in every male patient over the age of forty. You will often discover a small calculus just above the symphysis, particularly if you incline your tube so as to project the rays upward toward the umbilicus; in many cases I have found small calculi in the prostate which were hidden by the symphysis in the other view.

Dr. Edmonson. I think it is quite essential where you see any evidence at all of curvature in the ureter, that a roentgenogram be taken in the erect position. I have had a number of cases of curves, especially in the region approximating the kidney, where the erect posture produced, or converted them into, acute angulations.

Dr. Bowen. Dr. Nichols' paper is, in the first place, a sort of monument of team work. I do not think we have ever seen any work of this quality which was not the product of good team work.

The use of this type table has interested me considerably. We do our ureteral work in the Pennsylvania Hospital by having the patient catheterized at a considerable distance from the *x*-ray room and then carted down, with more or less unfortunate results.

I was particularly interested in what Dr. Nichols said about reports. I think we ought to stereotype consistently our expressions, especially in dealing with the men we are usually working with. Then we ought not to forget, when we are reporting to strangers, to be sure we are talking their language. We get into the habit of making our reports brief in a way that our own groups well understand, but the same words may be misunderstood by a stranger; especially if we make a study which we know is incomplete, we must not fail to express that fact plainly in closing the report. The mere omission of a few words may make the report misunderstood.

I was also particularly interested in the positions Dr. Nichols uses. We use stereoscopic plates and they seem to answer every purpose. This gives two positions, but they are more alike than his. I was interested to see the uniform posture results Dr. Nichols is getting.

One question I would like to ask with regard to ureteral cases that were followed by the opaque injection. I would like to know whether this is done at the time of the first examination; whether the plate is developed hurriedly and the examination made then, or at a second examination. In case of a small ureteral stone I believe it is, possibly, advisable to wait several days, because very frequently these small stones do pass after the ureteral catheterization, without any further trouble or manipulation.

Dr. Imboden. For many years we have used the stereoscopic method in examinations of the urinary tract. Occasionally a shadow was found in the kidney region which was difficult to differentiate from bodies other than those connected with the urinary tract. We have found that by making exposures on both inspiration and expiration some of our difficulties have been overcome. For instance, if there is a stone in the kidney, it retains its same relative position to the kidney on films that are made on full expiration and inspiration, but if the shadow is due to calcified gland its relationship to the kidney is changed, but not that to the spinal column. This examination does not pertain to the ureters.

Dr. Stewart. Would Dr. Nichols give us his differential points on the diagnosis of cystic kidneys by means of the pyelogram? I have always hesitated in attempting to designate the kind of pathology present from the roentgenographic examination alone. There are some tuberculous kidneys with a great deal of deformity and contraction and the presence of abscess cavities which can be recognized by pyelography. Cystic kidneys, however, do not give any characteristic shadow; consequently they are hard to recognize.

A number of years ago I made some original investigations and found that there was a normal excursion to the kidney, between full expiration and inspiration, of about 2½ to 2 in. and that one could easily demonstrate that the kidney descended in the erect position.

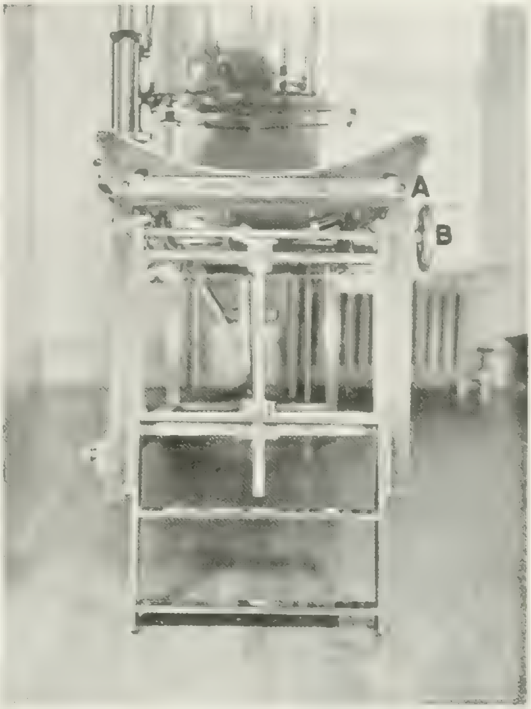
My experience does not tally with that of Dr. Jaches. In a number of cases we were able to demonstrate a kink to the ureter in the erect position, which, in the prone, did not show nearly as well.

Dr. Hickey. I would like to ask Dr. Nichols what he experienced as the proper method of preparing. I understood him to say not to use castor-oil. If he does not use castor-oil, what does he prefer?

I had a patient who had a large-sized stone in the kidney. I picked it up on fluoroscopic examination of the gastrointestinal tract, and I thought that would be a good chance to measure the excursion of the kidney. So I spent some time in measuring the excursion, and I found this shadow would move ½ in. during ordinary respiration, and on full inspiration would move 1½ in. This was quite a striking observation to me at the time, because I had not thought the kidney descended so far with the average patient in the course of respiration.

Dr. LeWald. I am interested in Dr. Nichols' table. Recently we have made all our examinations of the urinary tract on a Potter-Bucky diaphragm table. In order to give a tilt to the table we have added an elevating mechanism which I will illustrate.

I regard tilting of the patient as important in making pyelograms, since in some cases of partial double ureters we may in this way cause the opaque solution to run into the bifid ureter, if the patient is in a slightly inverted position with the head lowered. Of course, the reclining or vertical position is equally important.



Potter-Bucky diaphragm table with elevating attachment for cystoscopic use. Also can be used for mastoid and sinus work. (*A*) Holder for knee support; (*B*) elevating wheel.

Dr. Childs. In reference to this point that Dr. Hickey mentions about the change of position of the kidney in respiration, I will state that in conjunction with Dr. Spitzer of Denver, a series of cases were examined to ascertain the normal shape of the pelvis and calices of the kidney, and in these observations plates were made in the prone and erect posture, both on inspiration and expiration. We examined 29 cases—cases that by clinical evidence as well as by the radiological findings appeared normal. We found in these that the difference in excursion from full expiration to full inspiration varied from ¾ to 1½ in.

There is one point I desire to mention in the discussion of Dr. Nichols' paper, which paper I consider one of the best I have heard on this subject: that is, if an operation on a kidney in which a calculus has been definitely located, is to be postponed for two or three days, a subsequent examination, just prior to the operation, should be made. I recall one case in which two stones were demonstrated in the right kidney, both in the upper calices. A few days later, these stones were demonstrated in the pelvis; still a few days later, and just prior to the operation, one was demonstrated in the pelvis and one in the lower calix, and in the latter locations they were readily found by the surgeon.

Dr. Nichols (closing discussion). I am very grateful for this general discussion. I tried to bring these points out, but it is difficult to cover a large field without omitting some things of importance.

I was very glad to hear Dr. Jaches mention the point in reference to warts and foreign bodies on the surface which may give shadows simulating stones in the ureter or kidneys.

In regard to the question of examination without preparation: I would not say that is the best method to use, but that is the method we use from pure necessity. Most of our patients present themselves from quite some distance, and are perhaps examined that day and go right home. For this reason, we commenced it as a routine. It is best to prepare the patient beforehand, if you can, but we cannot do that. If we find a suspicious shadow, we have the patient return.

In regard to the use of castor-oil: It has been my experience that castor-oil produces an enormous amount of gas in the gastrointestinal tract. We prefer saline cathartic.

The question of upright position for making pyelograms has been fairly well answered. The consensus of opinion is that with this method, one can bring out kinked ureters that cannot be found with the catheter in position.

In regard to Dr. Bowen's question as to injection: We usually do this at the same time that we do the examination, without developing the plate. If there are clinical symptoms, we simply do the injection at the same time while the patient is on the table. It takes only a few minutes.

In regard to the point about Trendelenburg's position: We think that with the method we use of injecting the kidney and ureter, it is not necessary to put the patient in this position. We use the syringe method and inject until the patient feels a distinct pain inside. I think, if one is using a lesser amount of solution, one can, by the gravity method, bring out points in the pelvis and ureter that one cannot get by taking the picture in the horizontal position.

With reference to Dr. Stewart's comment on the polycystic kidney: As I stated, that case has not been operated upon, and I may be wrong. The patient is a man, perfectly well, weighing nearly 300 lbs. He complained of some disturbance in the back. Urine showed nothing. We could see, well outlined, cystic areas all over these kidneys—upper pole and lower on both sides. We concluded by the process of elimination, that it was a polycystic kidney. However, we may be in error.

Dr. Childs' point in regard to re-examining cases when operation is deferred, is well taken. It has been brought home to all of us that these stones have a peculiarity of changing position, particularly where there has been dilatation of the ureter and pelvis. If the patient is not operated upon on the day of examination, he should be examined at least very shortly before operative procedure is undertaken.

Dr. Bowen (after Dr. Nichols' closing). I want to say a word with regard to preparation. I have a very definite opinion that a properly given enema is the proper preparation. I want to agree with Dr. Nichols and go a little further by saying that I would rather not have the patient prepared at all than to have him prepared with castor-oil. Fasting and repeated enemas should be given until one is positive that the entire colon has been flushed. We then shall not have gas bubbles, and will have the patient properly prepared.

NEW LIGHT ON GASTRIC PERISTALSIS*

BY WALTER C. ALVAREZ, M.D.

From the George Williams Hooper Foundation for Medical Research, and the Department of Medicine,
University of California Medical School

SAN FRANCISCO, CALIFORNIA

Any roentgenologist who has not degenerated into a mere technician—a skilful hunter after filling defects—must often wish he could interpret more clearly the various forms of gastric peristalsis which he sees on the screen. He knows that they are atypical and perhaps abnormal, but the waves pass so rapidly, and so many things happen in different places at one time, that he cannot be sure of what he has seen. Even if he could be sure, he would not be able to tell the attending physician what it was all about, and where to look for the primary cause of the disturbance. Similarly, years ago, when I was a student in college, a heart, no matter how badly it was diseased, was uninteresting unless a big murmur could be made out. Today we are far more interested in defects of impulse origination and conduction than we are in murmurs. Volumes have been written on peculiarities of the cardiac impulse which were unheard of twenty years ago.

Now why has there been such a tremendous advance in our knowledge of the movements of the heart, and so little in our knowledge of the movements of the stomach? The answer is that the technique for studying the gastric movements is much the same today as it was fifty years ago, when the new methods of studying the heart began to appear. About 1870, men stopped *looking* at the heart, and began to record simultaneously the movements of auricles and ventricles on the same smoked drum. Later, they recorded the electrograms from two parts of the heart at the same time. The gastroenterologists have gone on simply looking at the stomach. To be sure, valuable work has been done with serial roentgenography, but the technique has been difficult and expensive; and, so far as I know, no professional physiologist has used it.

One of the principal reasons for this neglect of gastric physiology is that special types of apparatus have had to be designed to help in overcoming the technical difficulties which stand in the way. Imagine attempting to record the delicate movements of the cardiac end of an animal's stomach, situated as it is high up under a diaphragm which never ceases in its upward and downward excursions. That is bad enough, but just as an experiment is going well, along comes, perhaps, a deep sigh which tears off and disarranges the apparatus. It is not work for any one inclined to impatience or indulgence in profanity. Some may ask: Why not use balloons? The answer is that they slip about, and it is too difficult to say what they are recording.

DEVELOPMENT OF APPARATUS

In 1914, I devised a simple little enterograph, with which I was able to get records from two or three parts of the stomach and six or seven parts of the bowel at one time.[1] The animals were anesthetized and their abdomens opened in a tank of warm Locke's solution. During the last two years I have been developing apparatus which enables me to get electrogastrograms from six parts of the stomach and intestine at one time. I am also getting simultaneous electrograms and mechanograms from two segments of the stomach or bowel. Human electrogastrograms have been obtained with electrodes applied to the abdominal wall, and also with electrodes passed into the stomach.[2] I will not go into the question of technique at this time, partly because some of it has been published elsewhere,[3] but mainly because the apparatus is daily being changed and improved upon. Naturally, in the early stages of such a study, the interpretation of the records is difficult, and more new puzzles are found than answers to the original ones.

---

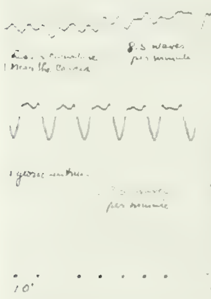
* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Cal., September 12-16, 192

WHAT HAVE WE LEARNED WITH THE NEW TECHNIQUE?

In the first place, it is clear that when the galvanometer is so arranged that an upward swing on the record indicates a negativity of the orad electrode, the electrical records look very much like the mechanical ones obtained by fastening a heart lever to the segment of stomach or bowel between the two electrodes. The gradient of rhythmicity from duodenum to colon[4] is again shown very clearly.

THE GASTRIC PACEMAKER

Both the electrical and the mechanical records show that many of the waves which seem to begin in the lower third of the stomach have really come as shallow ripples from the region of the cardia. There is an area on the lesser curvature next to the esophagus which appears to be the usual pacemaker, but it has not yet been localized with accuracy. It is clear from some of the records that the pacemaker can shift about, much as it does in the heart, and there are strong indications also of dissociation between the activities of the fundus and the pars pylorica.



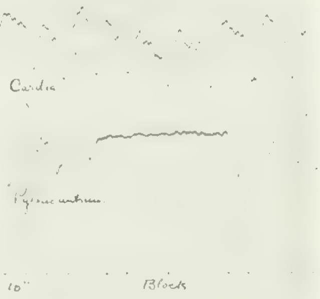


Fig. 1*a*. Fig. 1*b*.

Fig. 1*a*. Electrogastrograms from the lesser curvature near the cardia and the pyloric antrum of a cat. In all these records an upward swing denotes negativity of the orad electrode. The time record shows ten-second intervals. This record shows a dissociation between the activities of the fundus and the antrum.

Fig. 1*b*. Electrograms from the cardiac and pyloric regions of a cat, showing blockage of four waves.

STOMACH BLOCK

Just as in the heart, so in the stomach, we find blocks of short or long duration. We have found them most frequently at the junction between the body of the stomach and the pyloric antrum, but they can occur elsewhere, as at the cardia. Many of the records show also a phenomenon frequently observed on the screen, that is, the appearance of contractions which do not spread over the stomach, but spring up and die away in the same place.

DISSOCIATION BETWEEN THE FUNDUS AND THE PARS PYLORICA

I have long looked upon the stomach as two organs thrown into one; a crop and a gizzard; a hopper and a mill; an acid producer and a mixing chamber; but I was not prepared to find so much dissociation of rhythmicity as appears on some of the records. In some cases, the cardiac region seems to contract three or four times to the antrum's once; but there is seldom, if ever, any constant relation between the two rhythms; that is, one minute the ratio may be 8.5 to 3.4, and a little later it will be 9.3 to 2.6.

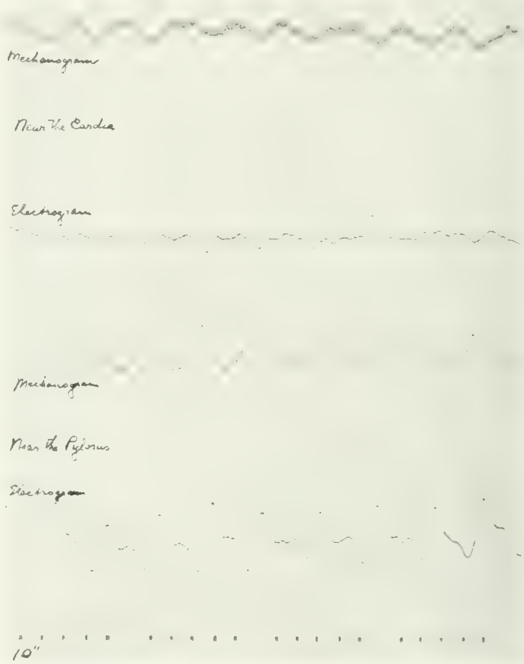


Fig. 1*c*. Simultaneous mechanograms and electrograms from two parts of the stomach of a rabbit.

GASTRIC SYSTOLE

Years ago, Cole noticed on his serial plates contractions of the stomach as a whole, which he called systoles. His fellow roentgenologists and the physiologists never seemed to take much stock in this observation, because they apparently could not repeat it for themselves; but I find a systolic type of contraction so frequently in my records, that I believe Cole was right. This brings out a point which I wish to make, namely, that we can easily miss things on the fluorescent screen, even when our attention has been called to them. How much more easily can we miss them if our attention has never been called to them. These systoles may have a considerable importance in gastroenterology, because the records suggest that they can have much to do with helping or hindering the escape of food from the stomach.

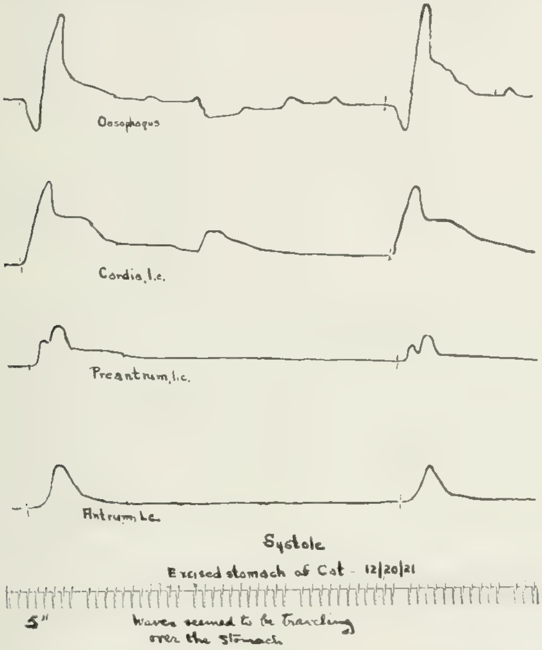


Fig. 2. Mechanical records from the lower esophagus, the cardia, preantrum and antrum of the excised stomach of a cat. It shows systoles and a lack of conduction at times from the esophagus to the cardia and from the cardia to the preantrum. The time record represents five-second intervals.

Another peculiar feature of these systoles is that they seem sometimes to be associated with peristaltic waves; that is, while a wave is slowly traveling from the cardia to the pylorus, another contraction which does not give rise to any peristaltic wave appears at the cardia, and is followed almost instantly by a contraction in the antrum. Sometimes it seems as if the antral contraction were in turn the origin of contractions in the middle of the stomach. For this reason, my assistant and I have come to speak of these easily recognized series of coupled contractions as "shuttle rhythm."

AUTOMATICITY OF THE PYLORIC ANTRUM

There are many signs in the records that the muscle in the pyloric antrum tends to contract at its own rate, which is about three times a minute.[5] Even when it is dominated by rhythmic stimuli coming down from the cardia, it will contract powerfully from time to time much as the ventricle of the heart does when it gives rise to extra-systoles. The frequency with which these large waves appear may have something to do with the rate of gastric emptying, and they may also produce pain in the presence of ulceration. Sometimes every third or fourth contraction on the record is twice as high as the others; and

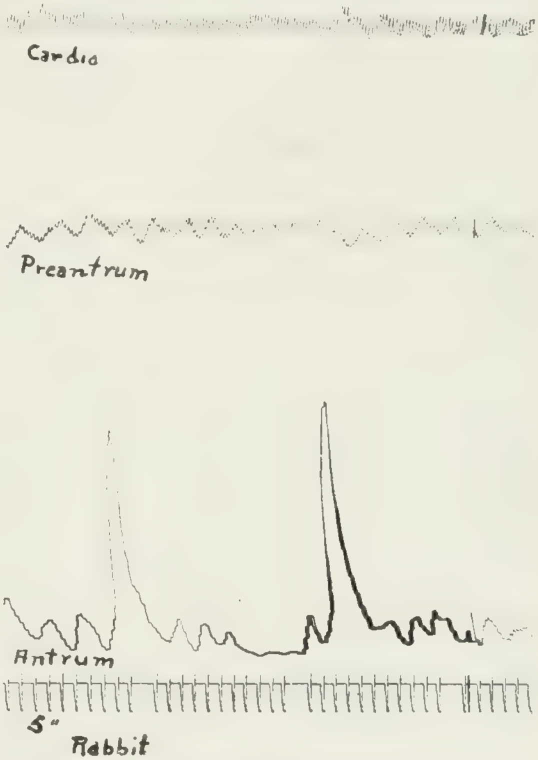


Fig. 3. Mechanical records from the cardiac, middle and pyloric regions of a rabbit's stomach. Note the occasional large contractions of the pyloric antrum.

rarely, every other antral wave is two or three times as large as its fellows, so that the record makes one think of pulsus alternans.

TWO OR THREE TYPES OF CONTRACTION AT ONE TIME

It is a remarkable fact that one point on the gastric wall seems to be able to respond to several rhythmic influences at one time. That is, the muscle, let us say, in the fundus, will contract at its own inherent rate of twelve times a minute.[5] At the same time, there may be slow tonus waves once every one or two minutes; and more rapid peristaltic waves once every twenty seconds. Conditions seem to be very similar to those in the bowel where there are the rapid segmenting movements, the occasional peristaltic rushes, and the large tonus changes which I have recently demonstrated. It will interest roentgenologists to know that Palugyay,[6] who screened the stomachs of several men and women while they were in the Trendelenburg position, observed frequent small waves in the fundus: waves different from those in the antrum. Forssell has made similar observations.

RELATION BETWEEN GASTRIC AND DUODENAL PERISTALSIS

Our records show that the tonus waves in the duodenum can be captured by the gastric rhythm and made to follow it for considerable periods of time; i.e., either simultaneously with, or shortly after, the arrival of a gastric wave at the pyloric line, there is a strong tonus contraction in the duodenum. This observation may throw some light on the mode of development of the pain in duodenal ulcer, because we now have every reason to believe that hunger contractions in the stomach will produce similar contractions in the duodenum. Wheelon and Thomas[7] have demonstrated this mechanism with the help of a very ingenious device.

It is interesting also to note that the peristaltic rushes which carry the food down the bowel almost always have their origin in one of these tone changes in the duodenal cap.

CONCLUSIONS

It seems clear, then, that the new methods have promise, and that they have already shown us a number of things which could not be detected by the unaided eye. Naturally, a beginning has barely been made; and much work will have to be done before we know just what relations these findings on animals have to the physiology and pathology of the gastric movements in man. The fact, however, that almost everything which has been discovered about the hearts of animals has had an important bearing on either the physiology or pathology of the heart in man, makes me feel hopeful for the future of this work on the stomach and bowel. I am not so sanguine about the future of practical human electrogastrography; but once the basic principles have been worked out, there is no telling what may be done, especially with the help of the amplifying electron tube which is now revolutionizing wireless telegraphy.

It seems to me that the main hope for the new methods is that they will enable us to recognize and evaluate symptom complexes in the history and on the screen—complexes corresponding to those which are now recognized so easily by the heart specialist, even without the help of his polygraph and his string galvanometer. The important point which I wish to emphasize is that he could not be making these diagnoses at all if he had not been working for years with his instruments of precision.

SUMMARY

Gastric physiology is far behind cardiac physiology today, because it has remained very largely in the crude stage of dependence on unaided visual observation.

Methods are now being devised for obtaining multiple and simultaneous mechanical and electrical records of the activities of the stomach and bowel.

A few records have been obtained of the human electrogastrogram. The electrograms from the digestive tract look very much like the corresponding mechanogram.

New evidence has been obtained as to the location and behavior of the gastric pacemaker. Stomach blocks and dissociations have been observed. Cole's discovery of gastric systoles has been confirmed.

Several peculiar types of peristalsis are described, and some contractions are shown which might perhaps be called, by analogy, pyloric extra-systoles.

Two or three different types of contraction can take place simultaneously in one segment of the stomach much as they do in one segment of bowel.

There is a close relation between the activities of the pyloric end of the stomach and the duodenum.

It is hoped that the new studies will eventually help the physician and the roentgenologist to recognize and interpret symptom-complexes, much as the polygraph and the string galvanometer have helped the heart specialist to recognize auricular fibrillation or heart block from the history, or from the feel of the pulse.

BIBLIOGRAPHY

1. Alvarez, W. C. *Am. J. Physiol.*, 1915, xxxvii, 267.
2. Alvarez, W. C. *J. Am. M. Assn.*, 1922, lxxviii, 1116.
3. Alvarez and Mahoney. *Am. J. Physiol.*, 1922, lviii, 476.
4. Alvarez, W. C. The Mechanics of the Digestive Tract. New York, 1922.
5. Alvarez, W. C. *Am. J. Physiol.*, 1916, xl, 585.
6. Palugyay. *Arch. f. d. ges. Physiol.*, 1921, clxxxvii, 232.
7. Wheelon and Thomas. *Am. J. Physiol.*, 1921, liv, 460; *J. Lab. and Clin. M.*, 1920, vi, 131.

THE BONE LESIONS OF SMALLPOX WITH REPORT OF CASES*

BY FRANCIS B. SHELDON, M.D.

FRESNO, CALIFORNIA

BECAUSE of the small amount of literature on the subject, and the lack of anything in the textbooks, I wish to present these cases, that we may be more on the lookout for the conditions.

In regard to the bone lesions of smallpox, I will quote Musgrave and Sison,[1] who report the following distribution of lesions: "Any of the bones and joints of the body may be affected. However, the long bones and their articulations are more frequently affected than other bones and joints. In the order of frequency the following locations of the lesions may be noted:

"1. The bones and joints of the upper extremity.

"2. The bones and joints of the lower extremity.

"3. The bones and joints of other parts of the body.

"The bones of the upper extremity may be involved in the following order of frequency:

"(*a*) Forearm (radius and ulna).

"(*b*) Arm (humerus).

"(*c*) Hand (carpal, metacarpal and phalanges—proximal and distal).

"The bones of the lower extremity may be also involved in the following order:

"(*a*) Leg (tibia and fibula).

"(*b*) Thigh (femur).

"(*c*) Foot (tarsal, metatarsal, and phalanges—proximal and distal).

"In regard to age, the bone lesions are usually observed in persons with a history of smallpox during early childhood, but the deformity may follow variola contracted at any time before the complete ossification of the bones. The greatest age at which such a complication of variola has been observed was fourteen years, in a boy.

"The fact that practically no mention of bone-deforming lesions as a complication of variola is found in current literature should make one very cautious not to interpret coincidence as cause and effect. The fact that the masses of the Filipino people are undernourished and underdeveloped as a result of starvation and metabolism incongruities adds to the difficulty of definite conclusions in interpreting the etiology of chronic bone-deforming lesions contracted during childhood.

"Both scurvy and rickets are much less frequently encountered in Manila than

---

[1] Musgrave, W. E. and Sison, A. G. The bone lesion of smallpox. *Philippine J. Sc.*, April, 1913.

*Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., September 12–16, 1922.

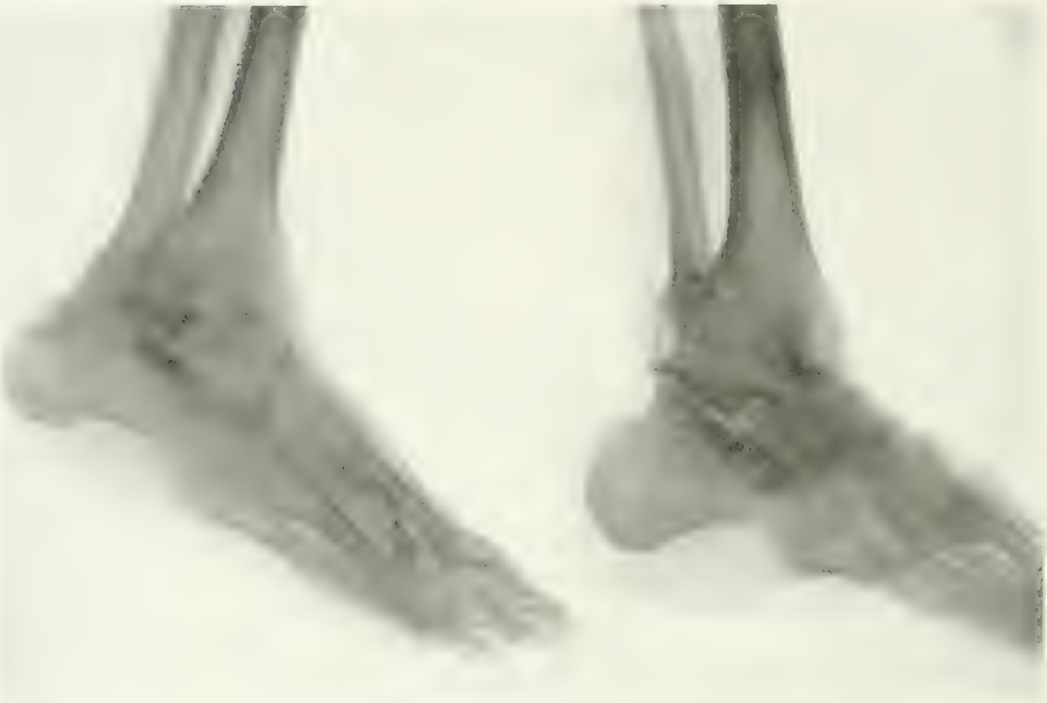


Fig. 1. Lateral view of both ankles.

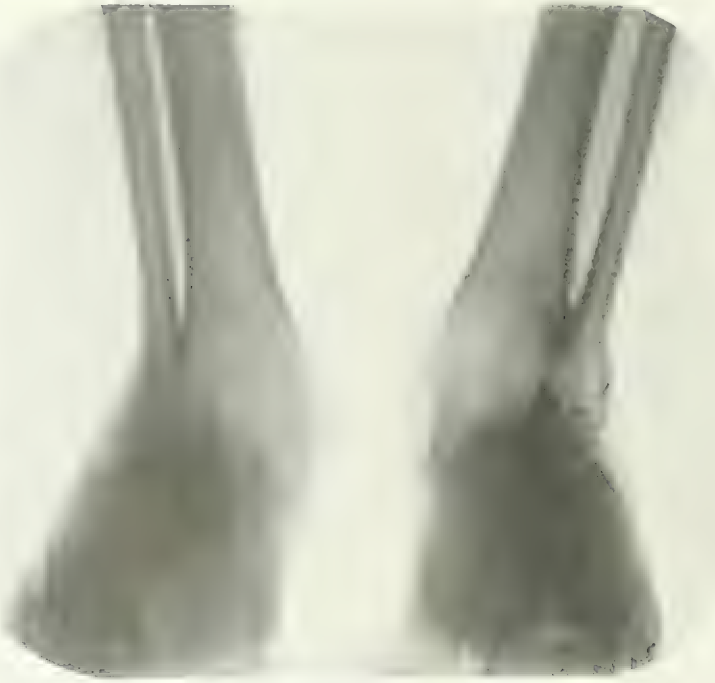


Fig. 2. Deformities of the ankles.

would be expected from the habits and faulty feeding customs of the people, and these diseases are less frequent in our large clinics than is reported from similar clinics in other parts of the world.

"The pathology of these disturbances, their mode of onset, and the course and results are now pretty well known, and do not correspond to the conditions found in our smallpox cases sufficiently close to make the danger of mistake in diagnosis a serious consideration.

"The close resemblance in the character of the deformities, their constant association with a history of smallpox during early life, and the absence of similar lesions under other conditions seem to warrant the conclusion that the deformities are a complication of variola.

"The morbid anatomy and histology of the lesions and deformities have been studied in one case by Crowell (Case III).

"In our preliminary report we stated: The process appears to be due to destructive lesions in the epiphyses of the bones. The shafts of the ulna and radius seem to be normal, except in length. The ends of the bones are enlarged and irregular in shape, and similar changes may be encountered in the carpal, metacarpal, and phalangeal bones.

"The circumferential growth of these bones is not disturbed in the least. There is no sign of underdevelopment in diameter, thus proving that the periosteum upon which the circumferential growth depends is not affected.

"The bones are markedly shortened and stunted in longitudinal growth; in some cases they are reduced to less than one-half the length of the normal bone. The obvious conclusion from this fact is that the seat of the primary lesion is in that part of the bone between the epiphysis and diaphysis which develops actively *ex utero*."

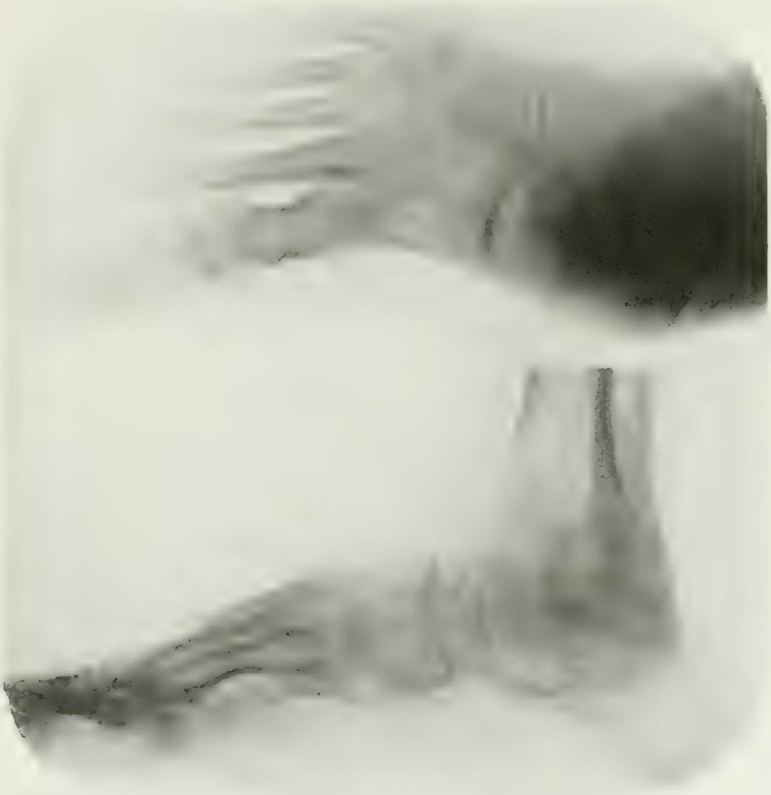


Fig. 3. Bone deformities of the right foot.

From their report of cases the following are taken:

Case I (No. 6992, 1912). Female, Filipina, twenty-seven years old, seamstress, born in Malabon. She had smallpox during childhood, and as a complication she developed deformity of the left elbow-joint, with partial ankylosis and shortening of the bones of the left arm and forearm.

Case II (No. 5368, 1912). Male, Filipino, born in Mindoro. Had smallpox when a little boy, and as a complication he developed deformity of both elbow-joints with marked shortening of the bones of the forearms and slightly of the arms, with partial ankylosis of both elbow and wrist joints. Deformity also of both knee-joints and some shortening of the bones of both legs.

Case III (No. 2464, 1912). Female, single, washerwoman, aged thirty-two, born in Silang, Cavite. Had smallpox when a little girl, with subsequent deformity of the elbow-joints and left wrist, with distinct shortening of the bones of the forearms on both sides. Deformity of both knee-joints and distinct shortening of the bones of both legs exist, with partial ankylosis of the elbow-joints.

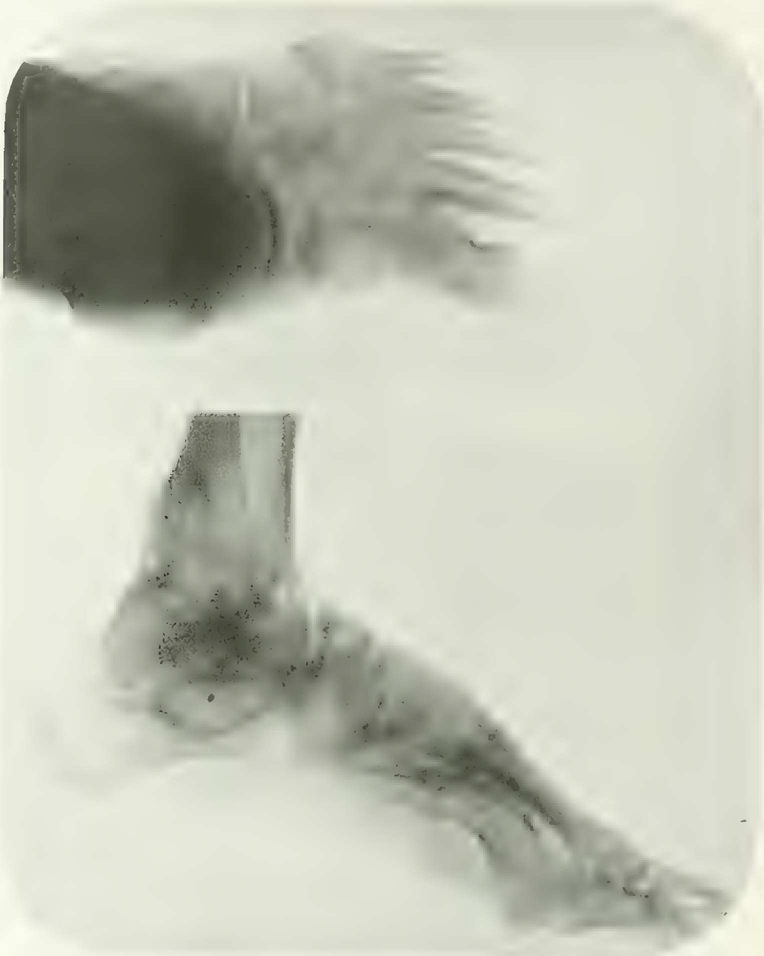


Fig. 4. Bone deformities of the left foot.

This patient died on March 22, 1912, and autopsy was performed by Dr. B. C. Crowell. Musgrave and Sison, in summarizing the bone conditions found by Crowell, say: "It is apparent that the diaphyses of the bones are shorter than normal, and that the ends of the bones, representing the original epiphyses, are much altered in configuration. In the shafts of the bones which were removed for examination there is no apparent change from the normal in contour or diameter. Mesial longitudinal sections through the ends of the bones show complete ossification of the epiphyseal extremities, and no indication of the line of junction between the epiphyses and diaphyses is present. The deformities of the epiphyses must, therefore, have occurred before the period of full growth, and the interference with the longitudinal growth of the diaphyses must have been due to some disturbance at the line of junction with the epiphyses.

"As is to be expected from the above description of the condition of the bones, examined at a period after the cession of active disease and after healing has taken place, the microscopic examination of the bones shows nothing which will further elucidate the nature of the active process. Complete ossification has taken place, and decalcified sections of the bones show no alterations from the normal condition of bone growth at this period of life. The epiphyseal line of growth is obliterated, and the compact bone and marrow bear normal relations. The only alteration is in the size and conformation of the epiphyses."

There were a number of other cases reported, but these few will serve to show the character of the deformities that these men have found.

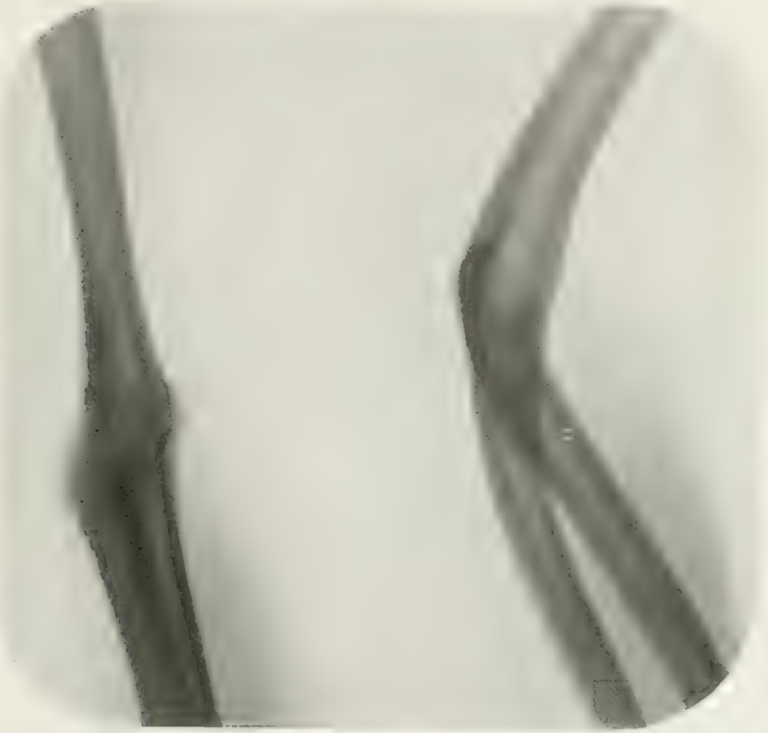


FIG. 5. Showing the continuous medullary canal from the humerus to the radius and ulna.

MY OWN CASES

I have personally seen two cases that I have recognized.

CASE I. A Chinese woman of about twenty-seven years, who gave a history of smallpox when three or four years of age. At the time seen she had deformities of both wrists and shortening of the right humerus and the bones of the right forearm. By measurement, the right humerus was 1 in. shorter than the left, and the bones of the right forearm were 1 in. shorter than those of the left. The ulna in each forearm appeared to be longer than the corresponding radius, causing deformities of the wrists. No roentgenograms of this case were possible.

CASE II. A Chinese, male, aged sixty-seven. Entered the hospital for pains in the feet. He was sent to the roentgen-ray department for roentgenograms of the feet and ankles. The films showed fusion of the distal extremities of the tibia and fibula. These also were fused with the astragalus. The first and fifth metatarsals of both feet showed shortening. From a diagnostic standpoint, the shortening of the bones and the deformities of both feet were probably the sequelae of smallpox. Under the fluoroscope, deformities of the hands and right elbow were noted.

Films of the right elbow show complete absence of articulation, and complete fusion of all bones. So complete is this fusion that the medullary canal of the humerus can be followed directly into that of the radius and that of the ulna. (This is the real three-in-one.)

The left hand shows marked shortening of the fifth metacarpal, and also a smaller shaft than the right fifth metacarpal.

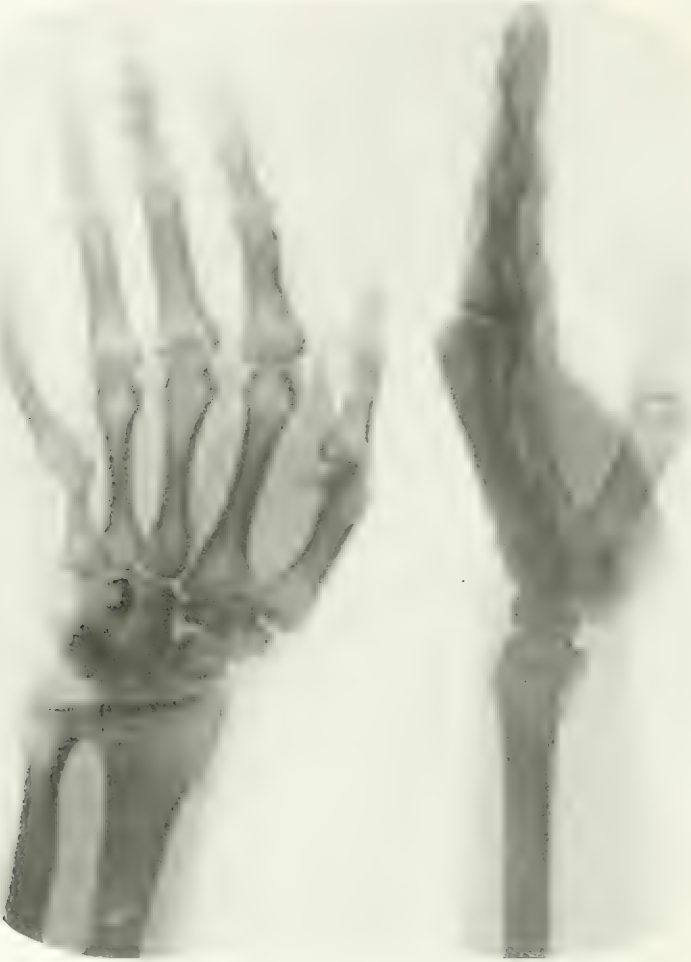


FIG. 6. Metacarpal changes of the left hand.

The right hand shows shortening of the first, second, and fifth metacarpals. Of these short metacarpals, there is but one that has a smaller shaft than normal. This is an exception to the statement of Musgrave and Sison quoted above, for they found no bones of lessened circumference.

The history of this man showed no bone injury, no evidence of inflammatory troubles, and no pains or aches until within the last six months, but there was a history of smallpox at the age of three years.

Physical examination shows no difference in the length of the two arms, but because of the ankylosis of the right elbow, the circumference of the right arm and forearm is less than that of the left. Examination of the mouth revealed a very marked pyorrhea, which, in all probability, was the origin of the infection causing pain in the feet.

The cases so far reported are from the Orient. Therefore I raise the question: Is the particular variola of the Orient different from that of the Occident, or are we simply not recognizing these cases?

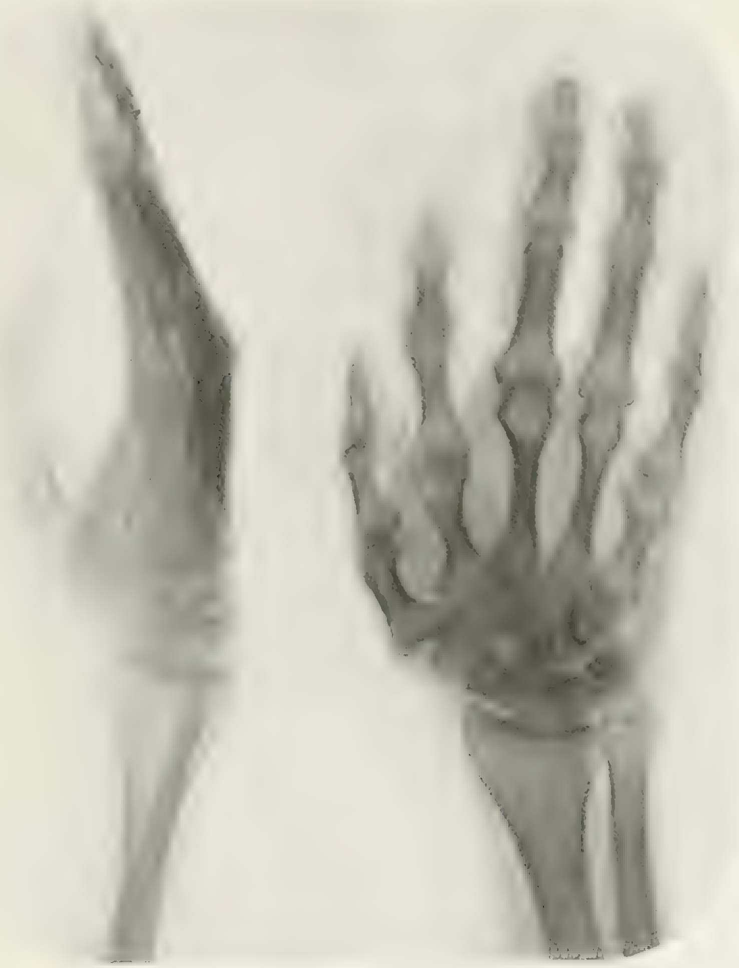


Fig. 7. Metacarpal changes of the right hand.

Since reporting the above cases, one case has been reported by Dr. W. L. Brown of El Paso. This was of disease contracted in Mexico; therefore, it is not an oriental complication.

THE DIAGNOSIS AND TREATMENT OF BONE LESIONS: A BRIEF SUMMARY OF THE SALIENT FEATURES*

BY JOSEPH COLT BLOODGOOD, M.D.

BALTIMORE, MARYLAND

I WILL attempt to give you briefly the salient facts which I have harvested from more than 1,000 records of bone lesions. This includes only those cases of tuberculous and pyogenic osteomyelitis which resemble clinically and in the *x*-ray a possible periosteal or central malignant lesion.

The Routine of an X-Ray Examination. With rare exceptions this should include the corresponding bone as well as the diseased bone. Especially is this important when the lesion is of slight extent and its interpretation obscure. My records show frequent mistakes due to this neglect. For example, a lateral view was taken of the tubercle of the tibia, because the child, aged ten years, had a painful swelling in that region, following a trauma. It was interpreted as a possible sarcoma, and exploration advised. When the roentgenogram was made of a similar aspect on the opposite side, it developed that the beak-shaped process of the tibia was even more suggestive of disease than on the evidently involved side. Nothing was done, and the child recovered without an unnecessary operation.

Roentgenograms Immediately after Trauma to Bones and Joints. We have educated ourselves and the public to the routine *x*-ray examination in cases of evident or possible fracture. But a similar examination is not being made as a routine procedure after a contusion of bone or sprain of a joint. This examination is essential for more than one reason, and perhaps the least important is the bringing to view an incomplete fracture. Such an examination will reveal the condition of a bone or bones at the time of the injury, and may reveal a preexisting osseous lesion, and—most important of all—is a record for comparison if the trauma excites some benign or malignant pathological process.

In only two of all my cases of sarcoma after trauma, do we have roentgenograms which were made directly after the injury, showing a normal bone, and later ones, clearly demonstrating the development of sarcoma.

In the past two years, due to the fact that both physicians and roentgenologists are realizing the importance of this routine examination, I have accumulated numerous roentgenograms made immediately after a contusion or a sprain which show a definite preexisting bone lesion. In the majority of cases, the lesion has been a partially or completely healed bone cyst; a few showed healed tuberculosis. (*Minn. Med.*, 1922, v, 604.) This examination, directly after an injury, is of additional importance in relation to the workmen's compensation laws and accident insurance.

X-Ray Examinations of Multiple Bone Lesions. It is now well established that the skeleton may be the seat of multiple lesions, and yet only one lesion may attract the attention of the host by pain or swelling. Therefore, it is a good plan to make examinations of all bones. It is my opinion that this should be done in almost every case. When the *x*-rays show multiple, distinctly central lesions, we can practically exclude primary sarcoma, and the diagnosis rests between metastatic carcinoma, multiple myeloma, multiple bone cysts and chondroma. When a distinct periosteal multiple lesion is found, we can exclude malignancy—either sarcoma or metastatic carcinoma. There may be a few exceptions to this rule. For example, a patient suffering with Paget's disease of the skeleton, which is a multiple periosteal lesion, may develop a periosteal sarcoma of one bone. I think I have such a case under observation now, which I reported in the *Journal of Radiology* for August, 1922, as an example of multiple infectious ossifying periostitis.

The demonstration of multiple exostoses excludes malignancy. It is a congenital hereditary disease of the skeleton.

---

* Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

X-Ray Examinations of the Skull. Recent experience has taught me that it is difficult to distinguish between a primary periosteal lesion of the skull and a central lesion which has perforated and broken through. In a recent clinic in Portland, Oregon, Dr. Sommers brought in a man with an evident periosteal lesion of the shaft of the femur and multiple lesions of the skull. I interpreted them as of periosteal origin, and naturally concluded that the bone lesion was inflammatory. Yet, a few days later, when Dr. Sommers explored the femur, he found sarcoma.

The interpretation of roentgenograms of the skull in relation to evident foci in the long bones is not yet firmly established, and needs further investigation.

I, therefore, urge that before making a diagnosis of a single bone lesion, roentgenograms of other bones be made.

Roentgenograms of the Chest. This should be a routine examination. In a number of my cases of periosteal sarcoma, within three months after the observation of the first symptom, we have found evident metastasis to the lungs in the routine roentgenograms before the patient exhibited any clinical symptoms. The demonstration of evident tuberculosis in the chest is very suggestive that the bone lesion is also tuberculous. Up to the present time, I have not found tuberculosis of the lungs in cases of sarcoma of bone—of this I am positive. Nor do I remember it being associated with bone cysts, giant-cell tumors, chondromas or myxomas. But this point has not been verified recently.

Palpation. I urge all roentgenologists to develop their sense of touch for diagnostic help in reading the films. Again and again cases have come under my observation in which the palpation of the periosteal bone lesion excluded the sarcoma which had been diagnosed from the roentgenogram. When the palpation of the periosteal bone formation shown is as evidently bony as the feeling of your own shin bone, you can be quite certain that it is not malignant. At the present moment, I do not remember having received a single report from a roentgenologist in which there is a note on palpation.

When you palpate about the bone a soft-part tumor, and the *x*-ray film shows that this tumor is composed only partly of new periosteal bone, then you have definite evidence that the lesion is periosteal or a soft-part lesion with secondary involvement of bone. But, unfortunately for the simplicity of diagnosis, and fortunately for the patient, this by no means indicates sarcoma.

As far as my own experience goes, I am just beginning to learn the value of the association of palpation with the study in the roentgenogram of the bone changes and the soft-part tumor, and I record here only those points which, I feel, are established.

Spindle-shaped Periosteal Growth Surrounding the Bone. In the older textbooks and the literature this was looked upon as pathognomonic of sarcoma. My experience teaches the contrary. In the *Journal of Radiology* for March, 1920, I have illustrations of a roentgenogram (Figs. 81 and 82) of a femur about which, on palpation, there was a distinct periosteal and soft-part growth which was not entirely composed of bone. It was interpreted as sarcoma; the advised amputation was refused, and the patient is well today, more than eight years since the first observation. I have again reported this case in the *Journal of Radiology* for August, 1922, with other examples of "infectious ossifying periostitis" in which similar spindle swellings have been observed.

X-Ray Findings in the Soft Parts. Not infrequently, when palpation fails to reveal any evident tumor outside the bone, the roentgenogram may show it. This is a very important change to look for, because the demonstration of soft-part involvement by palpation or in the *x*-ray film outside the cortical layer indicates periosteal involvement, irrespective of whether the appearance of the bone suggests a central lesion or not; and this is essential in planning the mode of attack—a point which I will discuss later under the title Central and Periosteal Bone Lesions.

Calcified Areas in the Soft Parts Outside the Bone Involved. My experience, as yet, is too limited to write positively, but, especially when the bone lesion is near a joint, the evidence in the roentgenogram of darker areas suggesting calcium deposits with a definite clear area between them and the bone, or the new periosteal bone formation, is very suggestive of tuberculosis, and against sarcoma.

Other Routine Examinations. My records show that it is a grave mistake for the roentgenologist to attempt to make a diagnosis from the *x*-ray plate alone. He can describe what he sees in detail and give his interpretation, but this interpretation is often modified by other laboratory findings and the clinical picture. It should be the duty of the roentgenologist, when he is asked to make an examination, to insist upon a complete *x*-ray examination and urge, before his final opinion is given, that he know the clinical history and the result of the other laboratory investigations. Unfortunately, the records sent to me with *x*-ray films or plates, are usually incomplete in this respect.

In every patient with a lesion of bone, there should be a Wassermann test, a complete blood examination, an examination of the urine for Bence-Jones bodies, and a search for foci of infection in the tonsils, nasopharynx, teeth and in the genitourinary tract. The urine should be repeatedly examined for the Bence-Jones bodies, and there should be always a differential count of the white cells of the blood.

Diagnostic Salvarsan. When the roentgenogram shows an evident periosteal lesion and the Wassermann is negative, I always advise at least one dose of intravenous salvarsan. It is true that in the majority of cases of syphilitic periostitis, the Wassermann has been plus. But when I have given these patients salvarsan, the evident improvement in the local condition has been so rapid and so marked that it occurred to me years ago to use it as a diagnostic test. I now have four cases in which the Wassermann report was negative, the *x*-ray plate strongly suggested sarcoma, and after salvarsan intravenously, there was rapid improvement and a permanent cure.

Incomplete Examination. Numerous records have been received with the diagnosis of periosteal sarcoma, requesting advice as to whether the treatment should be amputation, or roentgen or radium therapy, but without a Wassermann test. The diagnosis has been often changed and a cure immediately established by making a Wassermann test.

Only in recent cases have the records reported an examination for the Bence-Jones bodies. In my experience the presence of Bence-Jones bodies in the urine establishes the diagnosis of an incurable disease—either multiple myeloma, or metastatic carcinoma.

Localization of Lesion. In a recent complete study (about to be published) of all the central and periosteal lesions of the phalanges, we found a single example of a central sarcoma of a phalanx, and no case of perisoteal sarcoma. This is an important point to remember. The diagnostic value of the localization in other bones, up to the present time, gives only approximate diagnostic help. For example, in the central lesions of the lower end of the radius, the chances are 90 per cent that it is the giant-cell tumor. Periosteal and central lesions of the metacarpal, metatarsal and tarsal bones are very rarely malignant; up to the present time I have not observed any lesion of a carpal bone, except inflammatory, usually tuberculous.

This point of the localization of the different possible bone lesions has not yet been worked out up to date for all bones.

Central Bone Lesions. If the *x*-ray examination shows a distinct central lesion with definite bone shell, with or without fracture, and no extra-osseous soft-part lesion, and palpation reveals nothing, and the patient is under fifteen years of age, we can be quite certain that it is not sarcoma, nor any other malignant tumor. The probabilities are that it is a bone cyst. The next possibility is the giant-cell tumor, rarely a chondroma, and, in a very few instances, tuberculosis. In my experience, operation is not indicated at once. One can watch the case under control of frequent *x*-ray examinations. This is especially true when there is a pathological fracture. This fracture cures the bone cyst, with rare exceptions, and subsequent roentgenograms will reveal the rapid ossification, not only of the fracture, but of the central area of destruction. When rapid ossification does not show, operation is indicated at once. This operation will hasten the healing of the bone cyst, and is the best treatment for the giant-cell tumor or chondroma.

My experience teaches me that when the roentgenogram shows no fracture, an operation promises a more rapid and permanent ossification if the lesion proves to be a bone cyst, and, of course, as said before, this is the best treatment for the giant-cell tumor and chondroma.

If the patient is over fifteen years of age, and the roentgenogram shows a central lesion with a definite bony shell, with or without fracture, my evidence indicates that nothing is to be gained by delay; sarcoma cannot be excluded. It is also very important to remember that the single central lesion may be the onset of a multiple myeloma before Bence-Jones bodies appear in the urine, and in which the other foci in the marrow do not show in the film. Also, it may be the first evidence of metastasis from a concealed primary malignant tumor, especially in the kidney and prostate. These two possibilities, however, are very rare.

The order of frequency of central bone lesions after the age of fifteen is as follows: Benign giant-cell tumor; the recent and the old unhealed bone cyst; the sarcoma; the chondroma; the myxoma.

My experience up to date seems to show that *x*-ray and radium therapy cannot be expected to affect the pathological process through a bone shell; moreover, when radiation therapy is used, it is employed largely for conditions in which it is neither necessary nor valuable.

The Method of Attack of Central Bone Lesions. When the roentgenogram shows a single central lesion, with or without fracture, in a patient over fifteen years of age, operation is indicated. The object of the operation should be to remove and destroy the pathological tissue within the bone shell, with a technique to prevent, as far as possible, the implantation into the soft parts of tumor tissue. This implantation is most dangerous in myxoma and next in chondroma. For this reason, under an Esmarch, I expose the bone shell, open it with the electric cautery, and unless I am confident that it is a benign bone cyst, I remove the tissue within the bone shell, using the hot iron as a curette. Then I swab the cavity with pure carbolic and alcohol; then I pack it with gauze saturated with 50 per cent zinc chloride. If the evidence is in favor of sarcoma, I would implant the cavity with radium and follow with postoperative radium or *x*-ray treatment. This method is unnecessary for the benign bone cyst, but it does no harm, and interferes very little with healing. It is essential for the myxoma, chondroma and the giant-cell tumor, except the employment of radium and *x*-ray therapy, which need only be used if malignancy is questionable.

The wound can be left open or closed, according to its size.

My personal experience with immediate bone transplantation into large cavities has been unfavorable, except in the bone cyst, in which, however, it is not necessary.

The Cure of Central Sarcoma. In the *Journal of Radiology* for March, 1920, I recorded four cases diagnosed central sarcoma in which the patients are living five years after operation. I now retract two. Pathol. No. 20115 (Fig. 12) is diagnosed on restudy by a number of consultant pathologists as a giant-cell tumor. Pathol. No. 19179 (Fig. 23) has now been placed by consultant pathologists as an example of an unhealed benign bone cyst. Pathol. No. 10602 (Fig. 26) has died of metastasis. This leaves but one undisputed example of a central sarcoma cured by amputation (Pathol. No. 14229, Fig. 29).

The probability of a cure of a central sarcoma after amputation is less than 10 per cent.

Among the recent cases, there is one in the upper end of the humerus, operated on by Dr. Bunts of Cleveland, that we feel is sarcoma. The patient is now well, almost two years after operation. The method of attack was somewhat on the lines indicated here. Then there is another case from the Mayo Clinic, which recurred after curetting, but not with thermal or chemical cauterization. This patient has also remained well now, more than five years since amputation.

In view of the fact that amputation has rarely cured the central sarcoma because of metastasis to the lungs, and because it is the rare central lesion and often difficult to differentiate from some variant of the bone cyst and the giant-cell tumor, it seems to me we are justified, when we have a central tumor of bone, with an intact bone shell, in using this method of treatment, even when the gross appearance at operation and the microscopic picture strongly suggest sarcoma.

I have previously reported this method of attack in central sarcoma in *Minnesota Medicine* (not yet published), and now have in preparation a more detailed contribution.

Perforation and Destruction of the Bone Shell. This is not diagnostic of malignancy. Perforation of the shell has been observed in chondroma and the bone cyst, and partial and complete destruction of the bone shell has been observed in the giant-cell tumor. This point has been fully described by me in *Annals of Surgery* (April, 1919).

Since the publication of this paper, two years ago, I have received the records and roentgenograms of a giant-cell tumor of the lower end of the radius, in which there was complete destruction of the bone shell with infiltration of the soft parts. Yet the surgeon had the courage to curette, and to transplant bone into the defect, and was rewarded by a permanent cure with very good function.

My records show numerous amputations for benign central giant-cell tumors, because diagnoses were made of sarcoma on account of the perforation and partial or complete destruction of the bone shell.

Periosteal Bone Lesions. The problem of diagnosis and the plan of attack are essentially different from those advocated for central bone lesions. Age is of no help in diagnosis. It is very difficult in many instances to distinguish the periosteal sarcoma with and without bone formation, from the benign periosteal lesions with and without bone formation. I have described these in the *Journal of Radiology* for March, 1920, and again in August, 1922.

Up to the present time, I have but two permanent cures after amputation for periosteal sarcoma—less than 4 per cent, and recently two cases which reacted favorably to radium. In one, it is permanent now two years; in the other, there has been a recurrence after eighteen months, but improvement is showing again after radium treatment.

The Method of Attack of Periosteal Lesions. At the present time, even with a very large experience, I am somewhat in doubt. I feel positive that each case should first receive salvarsan, and then *x*-ray and radium treatment. If there is no evident improvement, I am of the opinion that amputation should not be done without a microscopic diagnosis, except in those cases of periosteal sarcoma in which the diagnosis can be made positively with the roentgenogram.

In some surgical clinics, where the surgeon, or his surgical pathologist, is capable of making a correct diagnosis with a small element of error, the decision as to amputation can and should be reached at the exploration. In other clinics, where as yet the surgeon and his pathologist have had less experience, the element of error thus being larger, a piece should be excised with the cautery and sent to a number of pathologists for diagnosis.

Recent experience has demonstrated that the number of benign periosteal lesions of single bones resembling in the *x*-ray films and clinically periosteal sarcoma, is increasing. These patients got well spontaneously, before the days when patients came early for diagnosis and treatment. These benign periosteal lesions are: Ossifying periostitis, traumatic, infectious, syphilitic, tuberculous; exostoses, and some rare examples of osteomyelitis. Therefore, in view of the fact that the cure of a periosteal sarcoma is so infrequent even after amputation, and the possibility of error is yet so large, amputation should be considered only when other means have failed. It is important to remember that when the lesion is syphilitic, the favorable reaction to salvarsan will be rapid. If we are to see the good effects of radium or the *x*-rays, it should be at once, within two weeks. My experience is chiefly with radium; with ordinary *x*-ray therapy I have observed no results.

Unfortunately, in the traumatic and infectious ossifying periostitis, which, when it involves one bone, is characterized by great difficulty in the differentiation from sarcoma, but the lesion recovers very slowly, there is no reaction to salvarsan, and in my experience little benefit accrues from *x*-rays or radium therapy. For this reason, although the periosteal lesion shows no improvement after salvarsan or radium therapy, we must still consider the possibility of spontaneous recovery in the case of traumatic and infectious ossifying periostitis.

Of this latter group I have made a full report on my experience up to date in the *Journal of Radiology* for August, 1922. This lesion, which I take the liberty of naming infectious ossifying periostitis, because it resembles infectious arthritis, has been described in the older literature by Garré as *non-suppurating osteomyelitis.*

Conclusions. This summary demonstrates how much we still have to learn in the diagnosis and treatment of bone lesions.

I venture to suggest that further great advance must rest upon the accumulation of complete records with the follow-up system which can be restudied from time to time. All have a large opportunity to join and be helpful in this investigation.

BIBLIOGRAPHY*

Results of operations for sarcoma of bone. Discussion of Dr. John A. Wyeth's paper. *Ann. Surg.*, 1901.

Giant-cell sarcoma of bone. Report of a case of medullary giant-cell sarcoma of upper end of tibia in which tumor was apparently completely removed by chiseling without destroying the continuity of tibia, and a discussion of the facts which justify this more conservative procedure. *Johns Hopkins Hosp. Bull.*, May, 1903, xiv.

Bone cysts. *Jour. Am. M. Assn.*, Oct. 15, 1904.

Conservative operations on bone tumors. Based on the clinical and pathological study of the relative degree of malignancy. *Jour. Am. M. Assn.*, Feb., 1908.

Benign bone cysts. Ostitis fibrosa. Giant-cell sarcoma and bone aneurism of the long pipe bones. *Ann. Surg.*, 1910, lii.

The conservative treatment of giant-cell sarcoma with the study of bone transplantation. *Ann. Surg.*, Aug., 1912, lvi.

Bone tumors. Central (medullary) giant-cell tumors (sarcoma) of lower end of ulna with evidence that complete destruction of the bony shell or perforation of the bony shell is not a sign of malignancy. *Ann. Surg.*, Apr., 1919.

Bone cysts of the marrow of long pipe bones, benign and malignant. *Tr. M. Ass. Alabama*, Apr., 1919.

Bone tumors benign and malignant. A brief summary of the salient features. Based on a study of some 370 cases. *Am. J. Surg.*, Sept., 1920, xxxiv.

The diagnosis and treatment of benign and malignant tumors of bone. *J. Radiol.*, Mar., 1920.

Bone tumors. Central in the phalanges in the fingers and toes. Chondroma, myxoma and giant-cell tumors. *Jour. Orthop. Surg.*, Nov., 1920, ii.

Bone tumors. Myxoma, central and periosteal. (Their recurrence after exploratory incision and piecemeal removal.) *Ann. Surg.*, Dec., 1920.

Bone tumors. Benign bone cysts and ostitis fibrosa. *X*-ray—gross and microscopic features. *South. M. J.*, Dec., 1920, xiii.

Bone diseases. Non-suppurating osteomyelitis (Garré). Infectious ossifying periostitis (Bloodgood). *J. Radiol.*, Aug., 1922, iii, pp. 310–317.

Central bone tumors and their differential diagnosis; with special reference to the latent and unhealed bone cysts in adults. *Minn. Med.*, Oct., 1922, v, pp. 604–610.

Bone diseases, osteoporosis or lipomasia from fixation and non-use. *J. Radiol.*, Oct., 1922, iii.

---

* The author's contribution to the literature on bone tumors.

IONIZATION MEASUREMENTS*

BY GIOACCHINO FAILLA, E.E.

Memorial Hospital

NEW YORK CITY

DURING the last few years ionization measurements have assumed considerable importance in radiation therapy. It may be well, therefore, to summarize briefly the essential facts of such measurements, in order that this information may be easily available to the radiologist.

Ionization. The atomic structure of electricity, as well as the atomic and molecular structure of matter, is now firmly established. Electricity is made up of minute but discrete negative "particles" called electrons, and positive particles which, so far, have been found to be always associated with matter. We can say also that matter is entirely of electrical nature and is made up of groups of positive and negative particles variously arranged. Atoms and molecules are normally neutral, that is, the positive electricity is completely balanced by an equal amount of negative electricity. But under certain conditions a temporary unbalance may be brought about.

It is well known that some chemical substances, when dissolved in water, break up to a certain extent into positively and negatively charged parts. These were named *ions* (that is, wanderers). In recent years the term has been extended to include any atom or molecule or group thereof in any medium carrying a charge of electricity. The process of producing ions is called *ionization.*

The radiations of radium and *x*-rays have the property of ionizing substances in the extended sense. That is, they are capable of producing positively and negatively charged particles in a substance, through the liberation of electrons from the atoms. It is important to distinguish between this type of ionization and electrolytic dissociation. In the latter case the ions are produced when the substance is dissolved in water, and no other agency is necessary. A number of molecules break up in a certain definite way, forming the required number of ions to establish equilibrium. The ions then persist as long as the substance remains in solution. On the contrary, the other type of ionization is dependent on an external agency such as radium, and gradually disappears if the agent ceases to act. The extent to which the substance is ionized depends on the ionizing agent. But in any case, a very small fraction of the total number of molecules are in the ionized state at any one time.

Electric Current. Knowing that water is made up of molecules, we can think of a current of water as the migration of these molecules from one point to another. In an analogous way an electric current is nothing but a number of electric charges in motion. The carriers may be electrons or ions, or even dust particles. The essential thing is that electric charges be in motion. Just as a force must be applied to set water in motion (usually the force of gravitation) a force must be applied to the electric charges to produce the current. Such a "force" is called an electromotive force (e.m.f.) and is ordinarily expressed in volts. The terms "potential" and "voltage" are also used to express the same thing.

To form a mental picture of the flow of electricity, let us examine the circuit of Figure 1. *G* is an electric generator, *A* and *B* its terminals. The function of the generator (whatever its construction) is to pump electrons from *A* to *B* so that in consequence *A* becomes positively and *B* negatively charged. The more electrons the generator tends to crowd into the terminal *B*, the higher will be the "pressure" or voltage of the machine. Metals possess the property of having free electrons, that is, electrons which are capable of moving between the molecules. If we connect *A* and *B* by means of a wire, the electrons in the metal will be attracted by *A* and repelled by *B* and, therefore, will travel from *B* to *A* along the wire. This would soon neutralize the positive charge at *A*, were it not for the fact that the generator pumps the same number of electrons away from *A* and back to *B*. A fresh supply of electrons can then pass through the wire which closes the circuit. Since, however, the molecules of the metal offer a certain resistance to the passage of the electrons, a condition is soon reached in which the opposing force is equal to the actuating force. At this point there is a continuous current passing through the whole circuit depending in value on the e.m.f. of the generator and the resistance of the circuit. In this example the energy supplied by the generator is all used up in overcoming the frictional forces encountered by the electrons in passing through the molecules. It appears as heat in the wiring of the whole circuit.

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

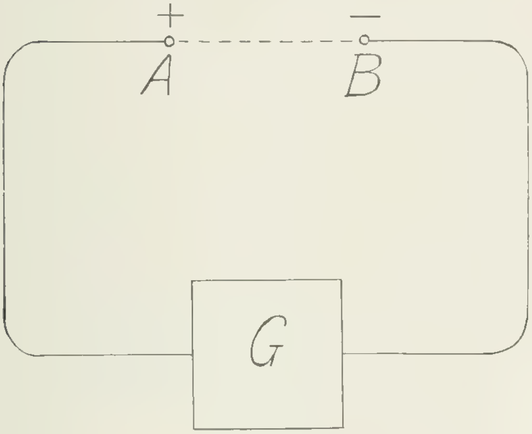


Fig. 1.

Ionization Current. If to the terminals *A* and *B* we connect two parallel metal plates insulated from each other by an air space, no appreciable current flows in the circuit, even though the e.m.f. be quite high. The reason is that ordinary air contains no free electrons and only a very few ions. Allowing a beam of *x*-rays to pass through the air results in the formation of ions, and a current is established. The negative ions travel toward the positive plate and the positive ions toward the negative plate. The magnitude[1] of the current depends on the number of ions reaching the plates per second.

In speaking of ionization it was mentioned that the ions soon disappeared after removal of the source of ionization. The reason for this is that the ions of opposite sign sooner or later come in contact and neutralize their charges. Evidently the same process takes place while the radiation traverses the gas, and the number present at any time is the difference between those which have been formed and those which have recombined. Accordingly the number of ions which reaches the charged plates per second is not necessarily the same as the number produced by the radiation, for some may have recombined *en route*. Obviously, the shorter the time interval between the instant they are produced and the instant they touch the plates, the less chance they have for recombination. The speed of the ions, other conditions remaining the same, depends on the voltage between the plates—the higher the voltage the faster the speed. So that, evidently, if the voltage is high enough, all the ions may reach the plates before any recombination has occurred. When this condition is realized, we obtain the maximum current which the degree of ionization of the air permits. This is called the *saturation current*, and can be taken as a measure of the number of ions produced per second in the air between the charged plates by the radiation. It is, perhaps, hardly necessary to mention that the farther apart the plates are, the higher the voltage must be to obtain the saturation current. Also the more intense the ionization is, the higher the voltage must be, since recombination can take place more easily.

From the preceding discussion it is apparent that to establish an ionization current, in addition to the presence of ions, it is necessary that they travel to the charged plates. Furthermore, to obtain saturation current it is necessary that they reach the plates before they have had an opportunity to recombine. The mobility of the ions is, therefore, an important factor in this connection. In gases they can move freely. But remembering that ions are always of molecular dimensions, we can readily see that their motion must be considerably impeded in solids and liquids. Therefore, in spite of the much more intense ionization on account of the closer packing of the molecules, ionization currents[2] in solids and liquids are, in general, much smaller than in gases. In addition, it is very difficult to obtain saturation current. In practice, air or some other gas is ordinarily used as the ionizable medium.

---

[1] It may be well to state here that ionization currents of this type at best are extremely small in comparison to the conduction current previously described.

Measuring Instruments. We have seen how saturation current is obtained when the ions are carried to the charged plates before they have had a chance to recombine. Under these conditions the resultant electric current is a measure of the number of ions produced per second in the air between the plates by the ionizing agent. Therefore, if we determine the value of the saturation current we know the degree of ionization in the air, and, if we wish, the number of ions produced per second. Ionization currents of this type are extremely small in comparison to ordinary electric currents. For their measurement, therefore, very sensitive electrical instruments must be employed.

All instruments for ionization measurements consist of three essential parts: (1) The ionization chamber in which the ions are produced; (2) the electrical instrument which is to measure the ionization current; (3) a suitable connection between the two. A source of potential is also necessary.

The ionization chamber can be of any desired shape or size. In its rudimentary form it consists of two electrically conducting surfaces properly insulated from each other and with an air space between them. The whole should be enclosed in a metal case or other conducting envelope and grounded, to avoid electrical disturbances and air currents. The voltage to be applied to the insulated surfaces to obtain saturation current depends on the distance between them and the intensity of the radiation to be measured. The pressure of the air or gas in the chamber has an influence on the minimum voltage to be used. In general, air at atmospheric pressure is made use of and the voltage applied is higher than is actually needed.

The electrical instrument used must be capable of measuring a very small electric current. Ordinary ammeters or milliammeters or even microammeters are not sensitive enough for the usual ionization measurements. The most sensitive galvanometers made can be used, provided the ionization current is sufficiently large. The operation of a galvanometer is based on the fact that a coil of wire through which a current flows becomes magnetized, and that the degree of magnetization depends on the strength of the current. In a galvanometer the electromagnet thus formed is made to interact with a permanent magnet, and motion of either one of them results. In the D'Arsonval galvanometer the coil is suspended between the poles of a permanent magnet by means of a very fine silver strip. To the coil is attached a small mirror, and the two turn through an angle when a current passes through the coil. By projecting a beam of light on the mirror, the reflected beam can be made to move over a scale and the motion of the coil be thus observed. The light beam serves as a weightless pointer of any desired length, and increases the apparent sensitivity of the instrument. This is the most practical type of galvanometer. The other type (Thompson galvanometer) in which the permanent magnet forms the moving element, while it can be made more sensitive, is more easily influenced by external magnetic fields and is not so reliable. With the D'Arsonval galvanometer of the highest sensitivity made by the Leeds and Northrup Company, currents as small as 10^{-10} ampere[3] can be measured.

A great many ionization measurements are made in which the current is much smaller than that which a galvanometer can measure. In such cases no electrodynamic instrument can be used, and we have to adapt electrostatic instruments for current measurements. The simplest of these devices is the gold leaf electroscope. The essential parts are shown in Figure 2. A strip of gold leaf *G*, about 2 mm. wide and 25 mm. long, is attached at one end to a flat brass post *P* which is supported on a good insulator *I*. The metal case *C*, which houses the leaf, may be of any desired size and thickness. If the electroscope is to be used with an ionization chamber, a wire, *W*, which is carefully insulated from the case, is connected to the leaf post. The leaf system, including the wire which is connected to one electrode of the ionization chamber, is charged to a voltage of about 300 volts by making contact with a suitable source of potential through the rod *R*. This means that electricity is "pumped" into the leaf system at a certain "pressure" or voltage. On account of the force of repulsion between the electricity in the gold leaf and that in the post, the leaf assumes a position such as at *a*. The higher the charging potential, the farther will the leaf stand out from the post. Each position then corresponds to a definite voltage. If the rod *R* is withdrawn, a definite amount of electricity is left in the leaf system, and the leaf remains away from the post. When the ionization chamber is exposed to radiation, the ions which are formed carry away the electricity from the leaf system more or less rapidly, depending on the intensity of the ionization. As a result, the leaf gradually falls back to its vertical position. The rapidity of motion is proportional to the ionization current. In practice a stop-watch is used to determine the time it takes the leaf to travel, let us say, from position *a* to position *b*. This time is inversely proportional to the value of the ionization current. The motion of the leaf is usually observed by means of a microscope.

---

[2] We are referring now to ionization currents produced by external agencies, such as *x*-rays.

[3] 10^{-10} ampere $= \frac{1}{10,000,000,000}$ ampere.

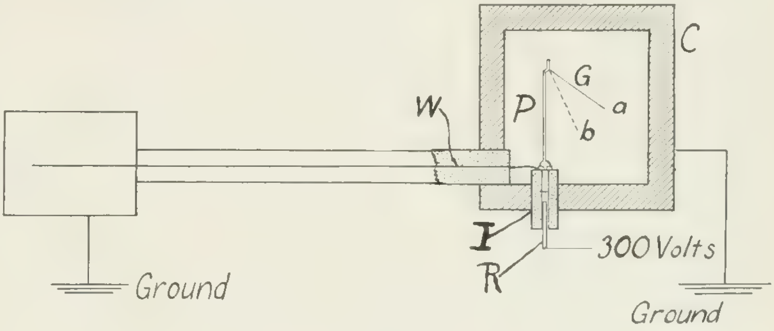


Fig. 2.

A mechanical analogy will make the operation of an electroscope clearer. The charging of the instrument is analogous to the inflating of a tire, the gold leaf corresponding to the pointer of a pressure gauge attached to the tire. If the air compressor is disconnected and there is no leak, the pointer of the gauge remains stationary. We then allow the air to escape slowly through the valve. The faster the air leaks out, the more rapidly will the pointer move toward the zero of the gauge. If we measure the time it takes the pointer to move from the 60 to the 50 pound mark on the dial, for different openings of the valve we can determine the *relative* amounts of air flowing per second for various valve settings. It will be noted that this does not tell us how many cubic inches of air are flowing out per second for any one setting; but simply that for one setting, say twice as much air escapes per second as compared to the flow for another setting. To determine the actual flow of air a special calibration is necessary. Similarly, in the case of the electroscope the readings which we obtain are relative. The analogy can be carried further. The time required by the gauge pointer to travel from the 60 to the 50 pound mark depends also on the capacity of the tire. The larger the tire the more air must flow out for this reduction in pressure. In the case of the electroscope, the larger the electrical capacity of the leaf system, the longer it will take the leaf to move between any two given points. Therefore, to make this time short and thus increase the sensitivity of the electroscope, we should make the electrical capacity of the instrument small.

An electroscope can be used without an additional ionization chamber, for in itself it is one. The leaf is at a high potential while the case is at ground potential, and therefore if the air is ionized a current can flow between the two. This is the way an electroscope is used ordinarily. It has then a small capacity and is very sensitive. When used in conjunction with an ionization chamber, special precautions must be taken to make sure that the current we measure is produced in the chamber and not in the electroscope proper. This means that the latter should be as small as possible, and made of thick lead to exclude the radiation which is to affect only the air in the ionization chamber.

We may now contrast the operation of the galvanometer and the electroscope. The former is an electrodynamic instrument, that is, it measures electricity in motion. Corresponding to a given electric current flowing through it there is a definite position at which the coil, and hence the beam of light, comes to rest. It will remain stationary as long as the same current flows through. The electroscope is an electrostatic instrument, that is, it measures electricity at rest. Corresponding to the amount of electricity which the leaf system contains (or what amounts to the same thing, to the voltage of the system) there is a definite position which the leaf will assume. It will remain stationary as long as the same amount of electricity remains in the leaf system. If the electroscope is to be used for current measurements, an additional instrument, that is, a stop-watch, is needed. In this respect it is not so convenient as a galvanometer, but since it is more sensitive it is more suitable for ionization measurements. It is also simpler, more rugged, and requires less attention than a galvanometer.

The third important part of an ionization meter is the electrical connection between the chamber and the measuring instrument proper. This usually consists of a wire with proper insulation. In the case of electrostatic instruments it is important that the wire be as small as possible, to make the electrical capacity of the system small if a high sensitivity is desired. The wire must also be shielded from electrical disturbances. This is accomplished by enclosing it in a metal tube, which is then connected to earth. This tube should be fairly large if a low capacity is required. When penetrating radiation is to be measured by the ionization chamber it is important that the current result only from the ionization in the chamber. For this reason the metal shield for the wire should be filled with a solid insulating substance in which no appreciable ionization current is produced by the radiation. In some cases it is better to make the walls of the tube of sufficient thickness to shut off the radiation from the air in the tube. This precaution must be taken for the electrostatic instrument itself.

The question of the proper substances to use to secure good electrical insulation is of great importance. There are no perfect insulators, but some are better than others. Amber is the best, and sulphur, hard rubber, pure gum rubber, and paraffin are good. Aside from the fact that they are conductors to a slight extent, they exhibit a peculiar property of "absorbing" electricity when in contact with a charged body. This electricity is then given up slowly when the body is discharged. In practical measurements this "soaking action" has the effect of increasing or decreasing the current measured by the instrument, according to the way it is used. Since the degree of soaking depends on the time the insulator is in contact with a charged body and the interval between successive discharges, the error introduced is variable. This is the most insidious source of error in ordinary ionization measurements with electrostatic instruments. Special precautions must be taken to insure uniformity of results.

The leakage of electricity through the insulator, which takes place principally by surface conduction, can be taken care of by applying a correction to the measurements. At the same time, correction is also made for ionization currents which may be set up in parts of the apparatus other than the ionization chamber proper, and for the current which may exist even though the source of radiation may not be acting on the apparatus. The correction is made as follows: The current measured by the instrument when the ionization chamber is exposed to radiation is made up of two parts: (1) that due to the ionization in the chamber produced by the radiation, and (2) that due to any other cause —conduction by the insulators, natural ionization of the air, stray radiation, etc. If we protect the ionization chamber from the source of radiation, then the only current measured by the instrument is part 2. By subtraction we obtain part 1, which is the current we are interested in. For accurate measurements the "leakage" current (part 2) should be small in comparison to the current we wish to measure. When a galvanometer is used in connection with an ionization chamber, the question of insulation, soaking, etc., is of relatively little importance.

All instruments used for ionization measurements give only *relative* values. A calibration of each instrument is therefore necessary. The unit adopted depends on the use to which the instrument is put. Thus for radium measurements the unit is the milligram of radium element; for radiotherapy it may be the skin erythema dose or any other unit. Whatever unit we select, the instrument, for accurate work, must be calibrated every time it is used, because variations occur over which we have no control. The best way to calibrate or standardize an instrument is by means of a radium tube placed in the neighborhood of the ionization chamber, always under identical conditions.

Radiation Measurements. Ordinarily in making ionization measurements we are not interested in the ionization *per se*, but rather in the radiation which produces it. The intensity of radiation at any given point is defined as the amount of radiant energy passing per second through an area of 1 sq. cm. placed at right angles to the line of propagation at the point in question. It varies inversely as the square of the distance from a point source. To determine it experimentally it is necessary to measure the amount of energy in the form of radiation which falls on a surface of known area during a certain time. In the case of heat or light this is a relatively simple procedure. But in the case of very penetrating *x*-rays or gamma rays it is extremely difficult. There is no instrument which measures radiation as such. Before a measurement can be made, the radiant energy must be transformed into some other form which can be measured. This means that the beam of radiation whose intensity we wish to determine must be absorbed completely. On account of the great penetrating power of *x*-rays and gamma rays, a large mass of matter (such as lead) is necessary for complete absorption. As a result, the energy is distributed through a large volume and is too small to be measured as heat, for instance.

When radiation ionizes a gas, it loses some of its energy, for work must be done to separate positive and negative electricity on account of the force of attraction between the two. If all the radiant energy were used up in producing ions in the gas, and we measured the resultant ionization, we could determine the intensity of the radiation. This, however, is not practical, for the ionization chamber would have to be extremely long.[4] Ordinary ionization measurements are made with relatively small chambers, and so only a small part of the radiation is used up in producing ions within it. This would be no objection, were it not for the fact that the fraction of the radiation thus absorbed is different for different qualities of radiation. Thus a beam of soft *x*-rays may produce an intense ionization, whereas a beam of gamma rays will ionize the gas only slightly, although the total energy in the two beams may be the same. We may conclude, therefore, that ionization measurements of radiations of different quality made with the same instrument do not represent the relative intensities of the radiation. If, however, we measure two beams of radiation of identical quality with the same instrument, the results give us a measure of the relative intensities. These two facts must always be borne in mind in interpreting ionization measurements of radiation.

Aside from the fact that radiation of different quality is absorbed to a different extent by the air (or other gas) of an ionization chamber, there are other factors which must be considered. The electrical instrument, by proper precaution, measures the ionization of the air. This, however, is not produced solely by the primary beam which traverses the chamber. The radiation which impinges on its walls is partly scattered in all directions, and this scattered radiation will contribute to the ionization. The latter is also increased by the action of the secondary and the characteristic radiations. The relative importance of the different factors which produce the total ionization measured by the electrical instrument depends on the quality of the radiation and the material of which the chamber is made.

---

[4] To absorb 99 per cent of the gamma radiation a column of air nearly one-half a mile long would be necessary.

Relation between Ionization Measurements of Radiation and Biological Effects. It is very likely that the biological effects of radiation are closely related to the ionization produced in the tissues irradiated. It would be desirable, therefore, to measure such ionization. However, the normal electrical conductivity of tissues is relatively large, so that the increase in the current which can be passed through them, due to the ionizing action of radiation, is completely masked. On this account, what is ordinarily done is to attempt to correlate biological effects and ionization in the air of an ionization chamber. We shall examine this problem to determine, if possible, under what conditions we may expect a parallelism between the two—biological effects and ionization measurements. To simplify our inquiry we shall assume that, other conditions being the same, the biological effect is proportional to the ionization produced in the tissues by the radiation. Our problem, therefore, is reduced to the comparison of tissue and air ionization under different conditions. If we can establish a parallelism between these two, then we *may expect* a parallelism between biological effects and air ionization. On the other hand, if there is no parallelism between tissue and air ionization, we *cannot reasonably* expect a parallelism between biological effects and air ionization.

It has been stated previously that the ionization in the air of an ionization chamber depends not only on the energy which is absorbed by the air from the primary beam, but also on the energy which is absorbed by it from the scattered, secondary, and characteristic radiations set up in the materials of which the chamber is made. We may conclude at the outset, therefore, that the construction of the ionization chamber must be taken into account. Scattered, secondary, and characteristic radiations are also involved in tissue ionization. The relative importance of each depends on the quality of the radiation which gives rise to them, and on the material in which they are set up. It follows, therefore, that if we desire a close relation between tissue and air ionization for different qualities of radiation, we must make our ionization chamber of some material which has nearly the same chemical composition as tissue. Friedrich,[5] after a careful experimental investigation, concluded that for therapeutic *x*-rays a small ionization chamber made of horn and graphite is satisfactory.

Let us consider now some of the measurements which we may wish to make in practice. All ionization measurements in which the quality of radiation remains the same are comparable to tissue ionization. For instance, suppose we give an *x*-ray treatment with a definite set up and we find that an erythema dose is obtained in 60 min. when a current of 3 ma. flows through the Coolidge tube. We then wish to use 6 ma. of current with the same set up, but we are not sure that the milliammeter is calibrated correctly. If the voltage on the tube and the filter are the same in the two cases, the quality of the radiation is substantially the same.[6] Ionization measurements can then be relied upon to give the correct dose for the 6 ma. setting, even though the milliammeter may not read correctly. In this case the construction of the ionization chamber is of little importance. It may be made of a metal or any suitable material. Since the quality of the radiation is the same in the two measurements, the ionization produced in the chamber bears a constant relation to the tissue ionization, irrespective of the intensity of the radiation.[7] That is, let us suppose that the ionization in the chamber is 1 and that in the same volume of tissue is 1,000 when the 3 ma. treatment is given. Then for 6 ma., the two will be 2 and 2,000 respectively, if the meter is correct. In any case, as long as the same ionization chamber and the same quality of radiation are used, the tissue ionization will be, say 1,000 times larger than the air ionization. Dosage based on ionization measurements under these conditions, therefore, will be quite accurate (provided extreme variations in the time of treatment are avoided). If a different ionization chamber is used, the relation between tissue and air ionization may be 500 or any other figure, but it will remain constant as long as the same chamber and the same quality of radiation are employed.

---

[5] KROENIG, B. and FRIEDRICH, W. Physikalische und Biologische Grundlagen der Strahlentherapie. English translation by Dr. Henry Schmitz.

[6] A slight difference may exist on account of the rectifier in the circuit.

[7] It is, of course, assumed that the necessary precautions as to saturation current, insulation, etc., are taken.

This fact is made use of in the measurement of radium. Here the air ionization bears a constant relation to the amount of radium placed in a definite position. Double the ionization means double the amount of radium, and so on. The radium content of an unknown tube is then determined by comparing the ionization produced in the instrument with the ionization produced by a known amount of radium. Whether a good instrument is made of brass, lead, or gold has no influence on the result.

The construction of the ionization chamber is also of little importance (provided it is not too large) when dosage measurements are made for different target-skin distances. Here again the voltage and filtration must remain the same in order that the quality of the radiation shall be the same. Both the milliamperes and the target-skin distance can be varied simultaneously, and by ionization measurements, without special precautions, we can obtain the proper dosage.

Before taking up the problem of ionization measurements of radiation of different quality, there is another point which deserves mention. Supposing we have a tube of radium screened by 2 mm. of brass and a few mm. of rubber so that we get only gamma radiation. From clinical experience we may know that if the tube is placed at a distance of 4 cm. from the skin of the patient, a treatment of 2,600 mgm. hrs. will, in general, produce a definite erythema. We should like to know what milligram-hour dose to use to produce the same effect when the same tube is placed directly on the skin. Since the quality of the radiation is identical in the two cases, from what has been said so far we might conclude that the proper dose can be obtained by measurements with any available ionization chamber. This, of course, is not the case, because the distribution of the radiation within the ionization chamber must be considered. In the above example, if a small chamber is used, the rays traversing it are nearly parallel when the tube is placed at a distance of 4 cm., but they diverge rapidly when the tube is placed directly on the chamber. The ionization in the first case is fairly uniform throughout the air of the chamber, but very far from uniform in the second case. While this is also true of the tissue ionization in the two cases, the relative distribution for air and tissue is quite different on account of the much greater absorption of radiation by tissue. Under these conditions we cannot expect a parallelism between air ionization measurements and biological effects.

The question of the relative distribution of ionization within the chamber and in tissue is of still greater importance when radiation of different quality is employed. In such cases a relative variation in the distribution of ionization in air and tissue may take place in spite of the equality of distance. In addition, the relative absorption of the primary, scattered, secondary, and characteristic radiations may be quite different, depending on the difference in the quality of the primary radiation. On this account the ratio between tissue and air ionization does not remain the same, and we cannot expect ionization measurements to check biological effects.[8] When, however, radiations of the same type and slightly different quality are compared, the discrepancy is slight. If, in addition, the ionization chamber is made of organic materials, the quality of the radiation may vary considerably without introducing too large an error for practical purposes. It should be mentioned in this connection that a discrepancy of even 10 per cent is hard to detect in clinical work.

---

[8] This is clearly brought out by experiments reported in a previous paper (Some problems in radiation therapy, by G. Failla, E. E., Edith H. Quimby, M. A., and Archie Dean, M.D. Am. J. Roentgenol., 1922, ix, 479) where beta and gamma ray doses, empirically determined, were compared with ionization measurements.

In conclusion, we may say that ionization measurements of radiation for therapeutic purposes are reliable, provided the quality of the radiation and the distribution of the ionization in the chamber are not very different for the different measurements. The instrument should be properly designed and constructed as regards the type of ionization chamber, insulation, electrical shielding, screening from extraneous radiation, and saturation. It should be calibrated every day, or oftener if a change is suspected, by means of a radium standard.

COMPARATIVE MEASUREMENTS BETWEEN RADIUM AND X-RAYS CONCERNING ENERGY ABSORBED AT DEPTH*

BY HARVEY R. GAYLORD, M.D., AND K. WILHELM STENSTROEM, PH.D.

State Institute for the Study of Malignant Disease

BUFFALO, NEW YORK

THE improvement of the *x*-ray tube has made it possible to raise the voltage of *x*-ray apparatus to 200 kv. or better, and the question has arisen as to whether high voltage *x*-rays can compete with radium in large amounts for external radiation.

The advantage of radium has been that it gives off rays of much shorter wave-length than have yet been obtained by any form of *x*-ray apparatus. Our interest in high voltage *x*-rays was strengthened by the clinical results obtainable with large amounts of radium, and led us to believe that it would be possible with improved output in the matter of short wave-lengths from the *x*-ray tube, to obtain better clinical results than had previously been the case.

Having at our disposal both an adequate amount of radium, and *x*-ray apparatus capable of continuous operation at 200,000 volts, we have attempted to determine the relative penetrating quality of these two agencies by measurements at similar distances and similar distribution.

The effect of radium and *x*-rays upon tissue seems to be proportional to the amount of energy absorbed, whether the rays are hard or soft, *x*-rays or gamma rays. To measure the effective intensity of such rays at a given point, an instrument must be used which absorbs these rays in the same proportion as does the tissue.

Friedrich has perfected a special kind of ionization chamber which accomplishes this result. Following the description given by Friedrich, we have built ionization chambers of this kind, and have used them in the measurements about to be described.

To determine how closely measurements obtained with these instruments approximate the biological reaction of the tissues to radiation, we carried out the following experiments:

1. We wished to determine the erythema dose for a new *x*-ray system where this was not known. With one of the chambers, we measured the intensity at 6 cm. distance from a radium pack, and then the intensity at 30 cm. distance from the target of the *x*-ray tube actuated by a current of 200 kv. Knowing the erythema dose of the radium pack, we were able to compute the skin dose for the *x*-ray system. In actual practice, the computed dose was exactly right. A few months later, when a second machine was installed, we were able to repeat this procedure with the same results. The construction of the two *x*-ray machines was based upon different principles of rectification.

2. The intensity of *x*-rays was measured after passing through a paraffin block 4 cm. in thickness. Adjacent parts of skin were now selected. A computed erythema dose for the skin was given upon the bare skin. The paraffin block was placed upon adjacent skin, and a computed erythema dose for the skin beneath the block was given through the block. The two areas

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

of erythema which developed were practically identical, although the time of exposure through the block was twice that of the direct skin exposure.

It is well known that the absorption coefficients of the human body, water, and certain organic substances such as paraffin and beeswax, are approximately the same, and that these substances may be used in experiments to determine the absorption and scattering of radiation projected into human tissues.

These measurements were made with a trough containing water, surface measurements upon the surface of a trough, and depth measurements through the trough, with a second trough behind the ionization chamber to represent tissues of greater depth, the ionization chamber being always placed in the center of the field.

In the experiments made to determine the erythema dose for the unmeasured *x*-ray machines, the wall of the ionization chamber was made of celluloid and graphite, and contained a volume of about 1.5 c.c. The chamber and the electroscope were connected by an insulated wire passing through a brass tube which extends through a lead wall between the operating room and the radiation room, the distance being 8 ft. The measurements were made by taking the time required for the gold-leaf to pass over the same portion of the scale, with corrections made for leakage. In practice, it was proved that the lead wall and distance were not sufficient protection for radium measurements, and for this purpose, a special apparatus had to be constructed. The pack at present used in the State Institute has a radiating surface of 6.5 × 7 cm. At a distance of 6 cm. from the skin and with approximately 1.5 curies of emanation, it gives the standard erythema dose at 6,000 mc. hours.

From the measurements obtained, the standard erythema dose was determined for the *x*-ray machine at 2.3 ma. hours when operated under the following conditions: 198 kv. (measured with ball sphere gap of 12.5 cm. diameter); 3 ma.; .5 mm. copper filter; 30 cm. focus skin distance; 10 × 15 cm. field.

The radium pack, under these conditions, gives 17 per cent of the skin dose at 10 cm. depth, while the *x*-ray machine gives 29 per cent of the skin dose at 10 cm. depth; with 2.55 gr. of radium, the erythema could be produced in the same time as with the *x*-ray machine.

The percentage depth dose obtained from the radium pack at so short a distance shows an apparent advantage over the *x*-ray, and is dependent upon three main factors:

(*a*) The hardness of the rays.
(*b*) The large radiating surface.
(*c*) The wide angle of the ray cone.

In order to compare radium and *x*-rays under similar conditions, these factors must be made comparable.

1. The radium must be so disposed that an area, comparable to the radiating surface on an *x*-ray target, is obtained.
2. The distance must be the same or approximately the same.
3. The angle of the cones must approximate.

The shortest distance in which we could measure the intensity of the *x*-rays was 20 cm. from the target, and it was, therefore, necessary to measure the radium at the same distance. At this distance, the small ionization chamber attached to the gold-leaf electroscope was not sufficiently sensitive for the radium measurements. Furthermore, as before referred to, the distance and protection were not adequate. It was, therefore, necessary to build a special measuring apparatus for this purpose. It differs from the first apparatus only in details. The capacity of the ionization chamber was increased to 10 c.c. The insulated wire was 14 ft., and the measuring apparatus was a quadrant electrometer protected by a heavy lead block, 8 cm. in thickness. The results of the comparative measurements are shown in the table.

In order to determine whether the difference in size of the ionization chambers would affect the values of the percentage depth doses obtained, *x*-ray measurements were made with this chamber at 50 cm. distance (the device was too sensitive for *x*-ray measurements at 20 cm.). Measured at 50 cm., the value with the *large chamber* was 33.5 per cent, and with the *small chamber*, 34 per cent, showing a close agreement of the values obtained with the two chambers.

From the table, it can be seen that at 20 cm., *x*-rays at 200 kv. with a circular field of 13.5 cm. diameter, taking the focal spot of the target as .2 cm.^{2} filtered through .5 mm. of copper plus 2 mm. paper, gives 24 per cent of the surface dose at 10 cm. of depth, and that radium at a distance of 20 cm., with a field not larger than 25 × 25 cm., with a surface of 0.1 cm.^{2} filtered through 2 mm. of brass plus 2 mm. of rubber, gives 26 per cent of the surface dose at 10 cm. of depth.

DEPTH DOSE, 10 CM. DEEP AT 20 CM. DISTANCE, RADIATING SURFACE OF SKIN

		X-rays-200 kv.	Radium		
Field	Calculated maximum dose 44 per cent	Circ. 13.5 cm. d.	25 × 25 cm.		
		3 ma.	Equivalent to 64 gr.		
Radiating surface		Target 0.2 cm.^{2}	0.1 cm.^{2}	3 × 4 cm.	6.5 × 7 cm.
Filter		.5 mm. Cu+2 mm. paper	2 mm. brass + 2 mm. rubber		
Depth dose		24 per cent	26 per cent	30 per cent	34 per cent

In comparing these figures, it may be noted that the surface of the radium is less than the target surface taken, but that the circular field, 13.5, which was the largest obtainable with the *x*-ray tube at 20 cm., is less than the 25 × 25 cm. field for the radium.

With regard to the surface distribution of the two sources of radiation at a distance of 20 cm., the advantage in surface of the *x*-ray is not important. The difference in size of field which is in favor of the radium is also not of great importance; therefore, we may assume that the conditions are, for practical purposes, comparable. The factor of error in the results obtained may be as much as one or two units, but it is assumed that the difference between the two percentages obtained is at least one unit, which is, in reality, not less than 4 per cent in favor of the radium, and probably 10 per cent.

Let us assume that the extreme possibility is 15 per cent. Under the conditions stated, the advantages in favor of radium over the *x*-ray at 200,000 volts must be attributed to the shorter wave-lengths of the gamma rays of radium, and we may now ask ourselves whether there will be great advantage in increasing the kilovoltage of the *x*-ray system, for the purpose of obtaining harder rays, much beyond the 200 kv. now available. It has been claimed that the greater portion of the improvement to be obtained by raising the voltage is accomplished at approximately 250 kv., and from a consideration of these figures it would seem as though that was a reasonable conclusion. Certainly, if the minimum figures shown by these measurements are correct, it seems probable that we should be contented with *x*-rays of the wave-length producible at approximately 250,000 volts. This conclusion is entirely beside the question of whether voltage should be raised for the purpose of developing more energy from the *x*-ray tube. By noting on the table that when the radium surface is increased to 3 × 4 cm., the depth dose at 10 cm. is 30 per cent that of the skin surface, and that when it is increased to 6.5 × 7 cm., the percentage depth dose is 34 per cent, it becomes clear that the greater part of the performance of the radium pack is due to the large radiating surface.

As at present constructed, the large surface of distribution in the present form of radium pack involves the disadvantage of a wide angle cone, which means that a very considerable volume of tissue is necessarily radiated even when the lesion to be treated is small, and that the rapid spreading of the rays materially reduces the percentage depth dose. In this particular, the greater distances available in *x*-ray technique are a marked advantage in favor of the *x*-ray, the rays coming from the target approximating more and more to parallel as the distance increases.

Preliminary studies indicate that a better depth dose may be obtained with a better distribution of the energy by construction of a special device. The mechanical details of this arrangement are not definitely determined, but it may be stated that by taking advantage of the principle of crossfire and proper lead screening, an arrangement can be made by which, instead of projecting a cone into the tissue, a cylinder with practically parallel sides may be achieved. Furthermore, by this arrangement a concentration in the center may be obtained. Even distribution is achieved by rotation.

By means of the arrangement which we are now studying, automatic crossfire is achieved. A somewhat larger area of skin is utilized than in the form of pack commonly used, and an actual concentration in the center of radiation is accomplished by crossfire. The work is still in progress, but sufficiently far advanced to show that an improved arrangement is possible both in distribution and percentage depth dose.

Photographic films show that whereas, with a pack of present construction, at a depth of 5 cm., 30 per cent of the surface dose was measured, with the new construction, 60 per cent is attained. Thus for a given area, at a given depth, an improvement may be obtained which would render the efficiency of radium twice that of the old arrangement.

In considering the relative advantages of radium and the *x*-ray for external radiation, it must be remembered that to compete quantitatively with present *x*-ray equipment, huge amounts of radium would be required, the cost of which would be prohibitive. The difficulty of obtaining adequate protection from such large amounts, even if available, would constitute an insurmountable obstacle.

Moderate amounts of radium in properly arranged packs will, in some instances, be found to meet special conditions better than *x*-rays, but these occasions are few. With the improvements which may be expected in the near future, the field of usefulness for the moderate-sized radium pack will be increased. The advantages of *x*-rays apply only to external radiation. In those cases where the growth can be reached, and radium or emanation of radium can be planted into the substance of the tumor, *x*-rays cannot displace radium. They can, however, be usefully combined with implantation, and the problems presented by certain lesions may be best met in this manner.

DISCUSSION*

Dr. Viol. I wish to express my gratification after hearing the splendid paper of Dr. Gaylord, and the beautiful demonstration which Mr. Failla has given. The physicist stands in somewhat the position of a law interpreter, and perhaps, in some respects, the position of the minister, and I sometimes feel that radiologists make use of his services as some people do their religion; they are very attentive to the sermon on Sunday, but the application of the Sunday truths is often difficult on week days. So the radiologist, while appreciating the physicist's advice, finds it hard to make practical application.

The most important fact brought out by these papers is the confirmation which they bring of that statement by Kroenig and Friedrich, to the effect that the absorption in the tissue of the same quantity of radiant energy, whether *x*-ray or gamma ray, produces the same physiological reaction. This principle is one which the physicists have believed in for many years, but which the clinicians have not confirmed because of the lack of adequate measuring devices, and because of the inherently different modes of application of the *x*-rays and the radium rays. As Mr. Failla has pointed out, it is not possible to compare the effects of unscreened radium with those of *x*-rays and screened radium, since the beta rays, which come into play from the unscreened radium, produce such intense but superficial reactions.

Drs. Gaylord and Stenstroem, through their results, show what can be done by the proper use of good equipment, and Mr. Failla, by his detailed description, has brought out very clearly the difficult points which confront us in the apparatus used in the measurement of quantities of gamma and *x*-rays. There is no question that the measurement of the ionization produced by these different forms of radiant energy gives us the best means of measuring quantities of *x*-rays and gamma rays; and in the future this method promises much in the control of dosage.

---

* This discussion has reference to the preceding paper by Mr. Failla, as well as to the above.

The physicist is an interpreter rather than a law-giver, and cannot, therefore, be held at fault if, through the desire for simplicity, wrong principles have been set up. To cite a case where the principle is biological, rather than physical, we may take the conclusion of Seitz and Wintz, who have stated that the variation in the resistance of carcinoma cells to the influence of *x*-rays varies so little that they have established as a lethal dose for carcinoma a dose representing approximately 100 to 110 per cent of the skin erythema dose for hard *x*-rays. This is admirable in its simplicity, but, unfortunately, the clinicians do not find that the application of such a dose of *x*-rays uniformly causes the regression of the malignant growth. Similarly, from the physical standpoint, you will recall the diagram shown on the screen by Dr. Schmitz yesterday. You will recall the beam of *x*-rays passed through the pelvic area from the front, and another from the back, together with the figures at the side indicating the fraction of an erythema dose produced at different points throughout the body. These figures, it must be remembered, actually represent the intensity of radiation down the central axis of the beam, and consequently, apply really only to a line drawn through the body, since the intensity in the beam falls off in an appreciable degree as one passes away from the central axis of the beam. Hence, while data of this sort might seem to indicate that the entire pelvic cavity was everywhere receiving a full erythema dose, the fact is, that away from the axis of the crossing beams, the intensity is somewhat reduced. Points such as this must be understood by the clinician; otherwise, he may wrongly interpret physical findings.

The matter of dosage, of course, is a point of greatest moment to the radiologist, who in this matter is continually between Scylla and Charybdis. Not enough radiation, and a curative result cannot be expected. Over-radiation, and a bad result also is likely. Perthes, in a paper recently published in the French *Journal de Radiologie*, particularly calls attention to the danger of over-dosage; and I was glad to hear Dr. Lee call attention to the danger of over-dosage in his paper. Perthes tried to take into account the various factors coming into play when radiation is used to influence a growth, and considers three points particularly: First, the resistance of the tumor; second, the resistance of immediately adjacent normal tissues; third, the general bodily resistance of the individual. In the treatment of such a condition by radiation, Perthes believes that such a dose of rays must be used as will cause the retrogression of the tumor without devitalizing the adjacent normal tissues. If the patient's general condition will tolerate this amount of radiation, and the tumor can be caused to retrogress under such conditions, the progress should be favorable. If, however, the destruction of the tumor involves the devitalization of adjacent normal tissues, or there is too great a systemic reaction, then the outlook is unfavorable, since in the first instance it is unlikely that the local growth will be destroyed. More probably it will grow rapidly, and if the patient's general condition is poor, the end is soon.

The physical measurement of dosage by the methods which have been described in the papers of Drs. Gaylord and Stenstroem and Mr. Failla, are of the utmost importance in this important matter of dosage. This is particularly true for the *x*-ray, since different installations will have their own output which cannot be gauged except by measurement, while radium always gives off a definite kind of radiation whose quantity is proportional to the amount of radium.

In closing, I would heartily urge the members of this society to study carefully these physical papers when they are published, because I feel that they are of first importance, and probably are too technical for the radiologist to grasp completely, as they have been presented on the platform today.

Dr. Schmitz. I have been very much interested in the presentation of these papers and in their discussion by Dr. Viol. It has seemed to me that, in reading clinical observations, it makes quite a difference of what wavelength the radiation is. We have been very fortunate, in Chicago, in knowing the intensity we can obtain with the *x*-rays and gamma rays. We have worked with 200 kv. and with the gamma rays and if we compare the result obtained with the 200 kv. with radium, we make the following observation: With 100 kv. rays and radium it usually took the patient six weeks to get over the systemic reaction, and also from six to eight weeks, before any local reaction occurred, so that we could call the patient negative. With the 200 kv. the patient is negative in three weeks, and the systemic reaction is very much less than with the 100 kv. It seems to me that with the shorter wavelength, the effect is better on the tissues, and that the ideal would be, if we could, to produce with the *x*-ray the effect of the gamma ray of radium. It has taken us two years to estimate the exact dose for the skin. I am not saying that the erythema dose for different types of skin may produce entirely different reactions.

Therefore, we thought it would be better if we had some biologic reaction which would be the same as for the skin dose, and for that purpose we chose a loss of hair following radium application—the pubic hair. Therefore, we feel that we have a skin dose that requires only one interpretation, and not the interpretations that various people may give to the skin dose. With the established factors, we know just when they get this epilating dose. With a .5 mm. filter, a field 20 cm. square and 5 ma. to the tube, we gave this treatment. When the new machine arrived, we had two electroscopes, and also an electroscope which I had constructed at the University of Chicago, very much like that of Dr. Gaylord at Buffalo. With these three instruments we constantly have an epilating skin dose, so that when two instruments get out of order, there is still one left. We then began to work with the 200 kv. *x*-rays, and it was an easy thing to determine with the higher voltage what we should use to obtain the skin dose. Dr. Bachem thought forty min. would do, but I insisted upon seventy min. He wanted to know why I insisted on seventy min., and I told him if he would take my electroscope he would see that the time duration in minutes would be seventy. He doubted this, and then we found that his electroscope in transit had become very imperfect. We had it standardized again, and then it bore this out. In the table presented yesterday where the curves were given, I did not say this would give the intensity curve at all. I spoke of the intensities which were obtained in the *x*-ray beam. With the large beams which we use, from 20 to 25 cm. square, the difference is 5 per cent; hence, in the actual interpretation of these *x*-ray intensities, we are absolutely safe in using these intensities, and stating that the intensity is almost homogeneous with the tissue in which the cancer element, sensitive to radiation, is contained. That is why I do not go to the laborious work of determining for each and every centimeter of tissue. Of course we know that exists.

Dr. Stenstroem. First, I wish to point out, in order to avoid misunderstanding, that Mr. Failla's measurements ought not to be confused with our measurements. Mr. Failla compared the intensity from *x*-rays and from beta rays while we compared the intensity from *x*-rays and from gamma rays. When we are using the radium externally we are not using the beta rays at all. They are completely absorbed by the filter. It is not surprising that Mr. Failla did not get the same results with *x*-rays as with beta rays. One could not expect that. There are great difficulties in measuring beta rays with an ionization chamber, because the chamber cannot be made smaller than 1 c.c. capacity. If we are using a tube about 1 cm. long, and intend to measure the distribution of beta rays around it, the intensity will be so different in different parts of the chamber, that the measurements will not give us the true distribution.

As to Dr. Schmitz's remarks: I am surprised to hear about Dr. Schmitz's experience concerning the different reactions of patients toward different kinds of *x*-rays and gamma rays. At the State Institute in Buffalo our experience has been quite different. The reaction has been about the same for radium and *x*-rays at 200 and at 140 kv. When such comparisons are made, the amount of radiation must be measured with the right kind of an ionization chamber (built from organic substances and graphite). Correction for leakage must always be made when an ionization chamber is used for such measurements, and one must be quite familiar with these methods in order to get correct results.

We physicists are not trying to give you any more physical foundation than is absolutely necessary for correct treatment. As Dr. Viol pointed out, you can easily burn a patient inside the body without damaging the skin, if you are using "crossfire." If you are using the same voltage, milliamperage, focus-skin distance, filter, and size of field, for the treatment with your machine, as another doctor with another machine, you may burn your patient, or give him too small a dose, though the other doctor gave just the right dose. If you, however, give your patient the same amount of radiation on the skin and inside the body, measured in an accurate way by the ionization method as the other doctor, you, too, will give the right dose, and can be sure of not burning your patient, regardless of what kind of a machine you are using.

Dr. Gaylord (closing discussion). I had hoped that the simple facts brought out by our paper would not be obscured by our discussion. I desire to emphasize that our practical use of ionization methods has enabled us to determine the erythema dose by measurement of an unknown system for the production of *x*-rays.

At Atlantic City, I reported our first success in the use of this method. Dr. F. C. Wood remarked in his discussion of my talk, that he thought Dr. Gaylord and his associates had been very courageous, and extremely lucky.

In our paper, I pointed out that we have again done this with another unknown system and have determined with accuracy the erythema dose by comparing the energy from the tube with the radium pack by means of measurements with the ionization chamber.

We are about to install another new machine in Buffalo, and we shall again rely upon this method. In both these instances we began the treatment of patients and had treated a number before we saw the erythema.

The improvements in *x*-ray equipment are, of course, important; but to the radiologist, they are not nearly so important as a physical basis of measurement. If in Buffalo, we were asked which we would most willingly give up, I would say that we should forego the improved apparatus and retain the methods of measurement. These methods of measurement have been used in the United States with radium for some time past. An accurate physical basis of measurement which will enable us to repeat with accuracy both the amount and distribution of radiation at depth is essential before we can even discuss biological effects. In the past, we never quite knew what we were doing, and hence a great deal of loose speculation has resulted as to the effects of radiation upon the tissues.

The purpose of our paper was to emphasize not alone the accuracy of these methods, but to show that by them we can compare radium and *x*-rays, and should be able within the limitation of each to use them interchangeably, or to select those fields for which each is especially suited.

MR. FAILLA (closing discussion). I am afraid Dr. Stenstroem misunderstood my remarks concerning the reliability of ionization measurements. In my paper I discussed ionization measurements in general, and therefore my remarks did not necessarily apply to Dr. Stenstroem's work. I have compared *x*-ray and gamma ray doses myself and have found them in close agreement.

RESULTS AND TECHNIQUE IN THE TREATMENT OF CARCINOMA OF THE BREAST BY RADIATION*

BY BURTON J. LEE, M.D.

Memorial Hospital

NEW YORK CITY

As a part of the organized effort at the Memorial Hospital, which has been carried on for several years, to study and treat malignant disease in its many varied phases, a breast service was organized in 1919, to concentrate under a single head the work in this field. It has been my privilege to be responsible for this service, and the present paper presents a brief summary of the technique employed and the results accomplished up to the present time.

The cases under report were admitted to the hospital in the years 1918, 1919 and 1920, and none of our cases of the last year and a half have been included. We believe that too often radiation is thrown into disrepute as a therapeutic agent by over-enthusiastic reports of brilliant recent results. Certainly, any form of treatment applied to cancerous disease must stand the test of considerable time to determine its real value, and radiation is no exception to this rule. Further, a record of the exact status of the case at the time of admission, with continuous notes of observation and treatment, are useful, if one is to estimate what really has been accomplished.

TECHNIQUE

X-Ray Treatment. There has been an evolution in the *x*-ray treatment of breast cases during the past few years at the Memorial Hospital. Recently, and up to the present time, all treatments have been given by the ordinary type of *x*-ray machine, delivering a peak voltage of approximately 90,000. Some years ago, the exposures were three to four minutes each, with a spark gap of 8 in., and a focal distance of 8 or 9 in., using 4 ma. current and 4 mm. of aluminum filtration. These exposures were given at varying intervals, usually four or five weeks apart. Eventually, definite telangiectases appeared in the radiated skin, and, in one or two instances, definite epitheliomata developed in the site of the overradiated area.

Three or four years ago, the time period was lengthened to six or seven minutes with a spark gap of 10 in. and a 10-in. focal distance, with intervals between the treatments of about five or six weeks, the number of treatments given over any one area usually not being more than three or four. This type of radiation has undoubtedly a more penetrating effect and the skin becomes definitely pigmented, but up to the present time only a few cases have shown marked telangiectasis.

---

* Read at the Seventh Annual Meeting of THE AMERICHN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

Within the last year, stimulated probably by the recent work with the high-voltage machines, the time period has been increased from fifteen to eighteen minutes and longer, with a 10-in. spark gap and a 12- to 15-in. focus skin distance, using 4 ma. of current and 4 or 5 mm. of aluminum filtration. This technique has been used where the tumor of the breast was of considerable thickness and a definite radiation of the deeper tissues was desired. Where superficial, subcutaneous nodules were being cared for, the older type of radiation with five- or seven-minute exposures has been the usual procedure.

We have used the *x*-ray routinely for pre-operative treatment before a radical operation, giving one complete cycle of about four treatments over the whole breast and axillary and supraclavicular regions. Following operation, after the wound has completely healed, usually in two or three weeks, it has been our practice to give two complete *x*-ray cycles covering the whole breast and lymphatic drainage areas. We feel certain that unless a very definite and pronounced erythema of the skin is produced following *x*-radiation, a tumor lying in the deeper portion of the breast has not been sufficiently radiated.

Treatment by Radium. Treatment of breast carcinomata by radium has been applied by one of five separate methods of application or various combinations of them, namely: pack, tray, dental mould, insertion of bare emanation tubes, and the insertion of platinum needles containing radium emanation.

The pack has been frequently described by various members of the Memorial Hospital Staff, and I need not go into many details concerning its construction. Suffice it to say it provides a filtration of ½ mm. of silver and 2 mm. of brass, and for ordinary breast tumors and axillary nodes it is placed at a distance of 6 cm., maintained by a wooden block beneath the pack, giving a dosage of 8,000 to 9,000 mc. hours over an area of approximately 70 sq. cm. This is particularly of use, we believe, in breast carcinomata involving the chest wall and sternum, small tumors of the breast itself, and over the axillary and supraclavicular regions, particularly if the nodes are deeply placed. We make use of it also in metastases over bones with a similar dosage, and in spinal metastases at a distance of 10 cm., we give approximately 16,000 to 18,000 mc. hours of treatment, with considerable relief of pain in some instances.

The tray is a smaller external applicator giving the same filtration, but used at a distance of 3 cm. for more superficial and localized nodules, the dosage reaching 2,500 to 3,000 mc. hours. We have found, as our work has developed, that we are using the tray less and less, as the larger drainage areas, such as the axillary and supraclavicular regions, often contain deeply placed nodes which are more efficiently radiated by the pack than the tray.

The dental mould, carrying silver filtrated radium, we have used in a number of cases of Paget's disease of the nipple with a very limited lesion present, and, in one or two instances, in small inoperable carcinomata placed exactly at the junction of the chest wall with the breast, the mould fitting nicely over the carcinomatous mass. Radiation by this method has recently given some very satisfactory results.

The insertion of emanation bare tubes by means of a long needle carrying a plunger is being used very extensively in primary inoperable tumors, giving a dosage of approximately 1 mc. per c.c. of tumor tissue. Caution should be exercised that the bare tube is not placed nearer to the skin than 1 cm.; otherwise it may cause an area of ulceration. Also, one should be careful to avoid placing the bare tube directly against a rib or rib cartilage, because of the possibility of injuring the periosteum. The general tendency in earlier years was to give repeated treatment by bare tubes in small doses.

The present technique consists in carefully estimating the exact size of the tumor at the time of the original visit of the patient; and an effort is made at the time of the primary treatment to accomplish a complete radiation of the tumor, always, however, after an *x*-ray cycle has been given. In some cases now under observation, we believe no second introduction of bare tubes will be necessary in the breast tumor itself.

Localized subcutaneous nodules in the chest wall may also be cared for by the implantation of small bare tubes of 1 mc. strength beneath the nodule, but they may be equally well or even better treated by *x*-radiation. The introduction of bare tubes into axillary nodes has turned out to be a difficult matter, for without opening the axilla, one cannot accurately localize the nodes at the time of introduction, and so a satisfactory implantation may be impossible. We frequently find, on opening the axilla in the endeavor to isolate nodes, that it is easier to dissect out fat and nodes themselves than to attempt to introduce radium into the separate nodes. More recently, we are placing bare tubes along the inferior posterior aspect of the pectoral muscle, believing that a reasonably efficient radiation of the axilla may be accomplished by this means. Bare tubes should never be placed nearer than 1 cm. to the branches of the brachial plexus, as an intractable case of neuritis may ensue. In general, we have found the management of axillary nodes one of the big problems in the treatment of breast carcinomata by radiation, and we feel that our present means of attack is not wholly satisfactory.

Within the last eight months we have been using the platinum needle, giving a filtration of $\frac{4}{10}$ mm. of platinum, carrying radium emanation tubes of about 60 to 70 mc., giving a dosage of 50 mc. hours per c.c. The theoretical difference between this needle and bare tubes is that no foreign body is left in the tumor and a less accurate implantation is required. We have had some recent interesting regressions in tumors treated with this method, but have not sufficient data at present to make a satisfactory report upon the results obtained.

Pleural and mediastinal involvements have so far not been completely radiated, for the necessity of radiating normal tissue and the length of time required have made it difficult to accomplish. We are hoping that a treatment of the chest areas with our new high-voltage machine may give more satisfactory results in the pleural and mediastinal areas.

RESULTS IN VARIOUS GROUPS

Primary Operable Carcinoma of the Breast. Following radiation of a breast carcinoma, a definite fibrosis occurs in and about the tumor, but the mass present may not contain any definite living tumor cells. In a case which has shown considerable regression, if radiation is persisted in, and especially if bare-tube insertion or the platinum needle is employed several times, one is very apt to break down connective tissue in and about the tumor, causing an intractable ulceration. It is much wiser to avoid overradiation of such cases, being satisfied with a fair rather than a perfect result.

The average routine case in this group is given a pre-operative *x*-ray cycle, followed three to four days afterwards by a complete radical operation, using the Willy-Meyer-Halstead technique, both muscles being removed. A very long oblique incision is made, running 2 in. below the costal margin, and this usually enables complete closure of the wound. Very careful and wide dissection of fat and fascia underlying skin flaps is made. We have had but very few instances of skin recurrence in the clinic in the past three years, so that we feel that this type of operation without a wide sacrifice of skin, is justifiable. When the wound is completely healed, two or three weeks following operation, a complete postoperative cycle of *x*-rays is given. The case is followed routinely in the breast clinic indefinitely, month by month, and treatment is given as indicated.

Exceptional cases occurring in the primary operable group are the women at or above seventy years of age, which special group we have determined to follow through, entirely on the basis of treatment by radiation. Although some older women are perfectly good operative risks, we feel that this is a justifiable procedure in these cases, and we are following this limited group with a considerable degree of interest. Further, we believe that a definite obligation rests upon Memorial Hospital to develop data of this sort, and we believe that it is possible without added risk to our patients. We have had some very interesting and satisfactory results to date, covering a period, in some cases, of two years. The procedure for such cases is *x*-ray externally, and insertion of bare tubes into the tumor and axillary masses. We do not, however, feel justified in making a further report at present on these cases.

Primary Inoperable Carcinoma of the Breast. This constitutes one of our large groups, and certainly one in which, without radiation, a practically hopeless result must be expected by the surgeon in charge of the case. Of the 83 cases occurring in this group in the period covered in the present report, 26 were very advanced, the average duration of life after treatment approximating four months, with a total average duration of two years and 9.2 months. All the cases in this group are dead. Of the 57 more favorable ones which might reasonably be treated with some hope of success, 25 are alive at the writing of this report of those doing well. Of these, 12 are doing badly, and 13 are doing well. The average duration of life after treatment was two years and 3.1 months, the longest duration after treatment being four years and the shortest, one year and 5 months.

Recurrent Inoperable Carcinoma of the Breast. This is our largest group in which the surgeon must look to the radiologist for definite help, for treatment by radiation offers practically the only hope of checking the disease or curing the patient. In the years 1918, 1919 and 1920, only six patients presented themselves to the hospital whom we felt justified in classifying as recurrent operable carcinomata of the breast.

In the treatment of these cases, *x*-radiation has been by far the agent most often employed, and, the radium pack or radium bare tubes have been used in well localized, sharply defined recurrent masses. In comparing our series of recurrent cases, covering three years, with those of another New York Hospital where no radiation was used after operation or for recurrence, we find that our period of life following recurrence is three times as long as theirs. We feel, therefore, that the treatment of recurrent cases by radiation gives, without doubt, a marked prolongation of life. In our group of recurrent inoperable cases, we have felt it wise to make a subdivision between the really advanced cases and those in which reasonable hope of improvement might be expected from radiation. Excluding the very advanced cases, we have had 124 in the recurrent inoperable class, 31 of which are alive, some of them doing well. We therefore are greatly encouraged in the treatment of these cases by radiation.

Prophylactic Cases Reported for Treatment after Radical Removal of the Breast for Carcinoma. We have routinely given a pre-operative *x*-ray cycle for the past four or five years. We believe that it is of definite service, and that it does not materially interfere with wound healing. Sufficient evidence has not accumulated up to date to determine whether or not the preoperative cycle prevents or delays a possible recurrence, but we believe that it may do both. A later study, comparing a large group of cases in which a pre-operative cycle was not used with one at Memorial Hospital in which it was, may furnish some data to settle the question of usefulness.

Concerning the postoperative cycle, we feel certain that it is efficient and that it has given marked results in cases where it has been employed, for we know it lengthens the time between the operation and recurrence. We believe, too, that it may entirely prevent a recurrence, if properly planned and administered, and delay the rate of growth when recurrence has already occurred.

Pathology. As to the pathology of cases under our care, we have made an earnest effort to obtain microscopic sections of as many cases as possible in the clinic, but at present we have been able to obtain this information in only about 40 per cent of the cases. Up to the present it has been difficult to correlate the histological picture with the clinical behavior of the disease, although certain anatomical types follow a more or less fixed clinical course, but we hope that by observation and study we may reach a more reasonable basis for therapy for the various anatomical varieties of breast carcinoma.

CONCLUSIONS

All in all, the outlook in the treatment of carcinomata of the breast by radiation is a most encouraging one. We feel that in no case of mammary cancer treated by surgery can the proper use of *x*-radiation be discarded. Radiation, properly administered, is the most effective aid in the care of carcinoma of the breast surgically treated; and in every surgical clinic a pre-operative and postoperative cycle should be employed if best results are to be obtained.

As to the treatment of primary inoperable and recurrent cases: We feel that our best method at present is external radiation by *x*-ray, with a fifteen-minute exposure, 10-in. spark gap, and 12-in. focal distance, with 4 mm. aluminum filtration, and 4 ma. of current, followed by an implantation of radium bare tubes into the growth, giving a complete dose at the first sitting. We are greatly encouraged at the present outlook.

We know that surgery has something very definite to offer for the relief of carcinoma of the breast, but we also feel that a more careful follow-up of cases in the surgical field may reveal a much poorer percentage of five-year cures than is generally believed. Our own conviction is, that of 100 cases treated surgically, 15 to 25 per cent may be expected to be alive at the end of five years.

With such a discouraging outlook afforded by surgery, we feel that the addition of radiation to the treatment of this terrible disease should be followed in a most careful and systematic manner, the radiologist and the surgeon working together to solve the therapy of the disease.

DISCUSSION

Dr. Burnam. I notice the essayist did not mention the differences in the radiosensibility of the scirrhous type, the medullary type and the types of breast cancer. I believe there are other marked differences, depending on the histological structure. Small, round-cell, scirrhous tumors in old women are difficult to affect. It is well to remember that patients with microscopical evidence of cancer can live for years in good health. I recently saw a woman who had a small recurrent nodule in the scar of a breast removal of twenty years before.

We have had splendid results in bone metastases, particularly of the skull and spine. As these are the occasion of pain and disability, the relief of such metastases, even where general cure is impossible, may be of great value. I feel that radium offers a means of widely extending the surgical operation locally, and of taking care of some metastases. One case of adenocarcinoma of the breast (medullary type), which I have had under observation more than two years, seems almost as radiosensible as a sarcoma. Some other cases have stood radiation that squamous cell epithelioma would have yielded to, without being destroyed.

Dr. Gaylord. I did not hear all of Dr. Lee's address, but it seems to me that with regard to carcinoma of the breast, there is one definite problem, and that is whether we may substitute radium for surgery.

We have treated between 30 and 40 cases of early operable carcinoma with radium and *x*-ray combined.

I had the pleasure recently of showing 6 such cases to Dr. F. Finney, when he visited the Institute. Distinct evidence of carcinoma had disappeared, only small indurations being left. Dr. Finney was of the opinion that these cases should not be operated upon, but should be observed for a period of years for the purpose of determining the value of radiation in early carcinoma.

At the State Institute, where we maintain a diagnosis service for the surgeons of the state, we have witnessed in the last ten years a great change in the character of the specimens sent in. When the service started, 90 per cent of the specimens were carcinoma; today, this per cent is only 28; showing that surgeons are removing suspicious lesions much earlier than previously, and are also sending us earlier cases than before.

Dr. Pfahler. We have one patient alive eight years after a definite mediastinal involvement; another one lived six years and ultimately died of the disease. We have several others who have lived a shorter time.

Dr. Lee (closing discussion). In the first place, I think the surgical results to date, so far as I see the cases, are not as good as the majority of us believe. I followed through our cases at the Memorial Hospital for five years with and without metastases and find that the surgical results were much poorer than I had anticipated they would be.

Another point: A case that is clinically and primarily an operable carcinoma may not be at all a suitable case for operation. For instance, a young woman of twenty-seven, pregnant two months, with a rapidly growing tumor involving the whole breast, is not a case for operation. It is much better left alone, or the uterus emptied and the area radiated. I recently saw a case of this very type. Some men wanted to operate on this woman, but I advised strongly against it. We have had several cases at the breast clinic at the Memorial Hospital, with supraclavicular nodes as big as a fist, which we classified as inoperable. They have gone outside and consulted another surgeon, who has performed the usual radical breast amputation, and in six months have come back with nodes as big as ever. I think many cases should be treated surgically; for instance, 75 per cent of the operable cases at the Memorial Hospital, in the last five years.

As to pre-operative radiation, we do not feel that at present we have real evidence for or against it. We believe that ultimately a large series of cases may be compared with cases that have not had pre-operative *x*-ray; and in this way we may obtain some idea of the result that may be attained.

AN AUTOMATIC SWITCH FOR BUCKY DIAPHRAGMS

BY EUGENE VERNON POWELL, M.D.

X-Ray Department, St. Bartholomew's Clinic and Hospital

NEW YORK CITY

THE dissatisfaction with the devices ordinarily used to indicate that the grid of a Bucky diaphragm is moving, has been indicated several times by the published description of various substitutes. All the while, it seemed that something which would automatically make the exposure while the grid would be moving, and at the same time insure against the appearance of the "corduroy" markings, would satisfy the requirements completely. For that reason, the method which I have used in the *x*-ray department of St. Bartholomew's Clinic and Hospital since April, 1922, seems to merit description.

It consists, as will be seen in the accompanying sketch, of a sliding contact switch with which the "make" occurs after the grid has started to move, and which will break the circuit before the grid has again come to rest.

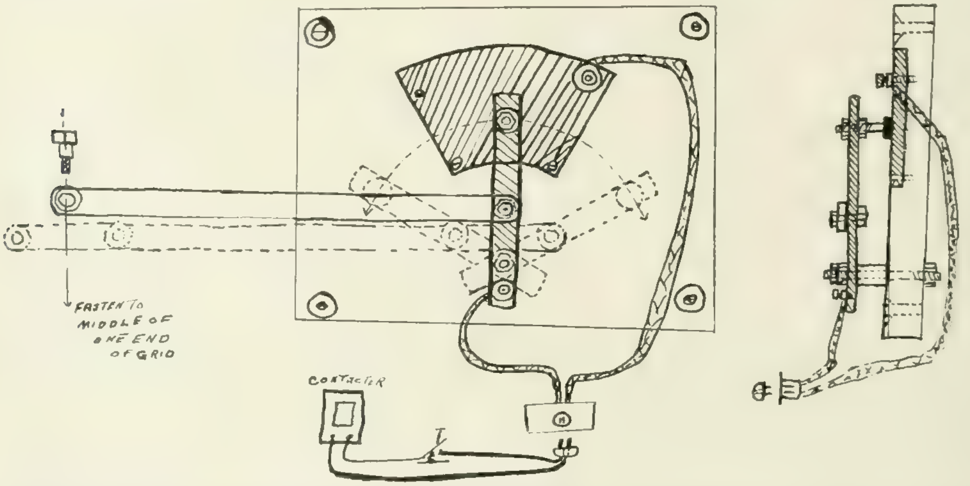
The fixed pole of the switch consists of a metal plate counter-sunk into a block of fiber or other insulating material so that the surfaces of the conductor and its insulating base are flush with each other, and so that the other pole of the switch may travel across the block without interference that will affect the motion of the grid, to which it is attached by a fiber arm. The length of the plate should be such that the arc described across it by the moving contact point will *not* exactly equal the distance between any two strips of the grid, so insuring that the metal strips are not in the same relative positions to the fiber at the beginning and end of the exposure. Also, the plate should be so placed in the block that contact is made approximately during the middle two quarters of the grid's excursion.

A binding post is fixed to the metal plate at such a place that it will be entirely clear of the movable pole.

The movable pole consists of a short metal bar, one end of which is fastened to the insulating block beneath the middle of the metal plate, and in such position that its free end may describe an arc across the fixed pole. Extending at a right angle from the free end of this bar is a screw with a rounded head. It is locked to the swinging arm at a length so as to make contact when it slides across the metal plate. When at rest, however, this screw-head rests on the insulating block. A second binding post is fastened to a convenient place on the swinging bar, near its fixed end. This bar is also connected to the middle of one end of the grid by a fiber bar, so that when the grid moves, the free arm of the switch is driven back and forth across the fixed plate.

The switch should be mounted at one end of the Bucky diaphragm and inside the frame by screws through the block near its corners, and with the back of the block away from the grid. When the top of the "Bucky" is replaced, the switch is entirely enclosed.

The leads from the two binding posts go to an attachment receptacle of the flush wall type. This should be located so as to open on the side of the Bucky away from that in which the cassettes are placed. An extension cord, when plugged into this receptacle, leads to the solenoid of a remote control contactor, such as is used on, or can be adapted to, any *x*-ray machine. The only reason for not taking these leads directly to the primary of the high tension transformer is that the arcing in making and breaking of heavy currents would probably soon destroy the sliding contacts. Somewhere in the leads, between the Bucky diaphragm and the contactor, a spring foot-switch should be placed in series with the sliding contact switch. As this will have to be closed when making the exposure, it will, when open, permit the resetting of the grid without intentionally opening the circuit elsewhere.



The shaded portions indicate the conductors. The positions of the swinging arm before and after exposure are indicated by the broken lines.

This device can be built in the laboratory, and, as it is complete in itself and in no way interferes with other signal devices, it need not be used unless so desired. The length of exposure is entirely dependent on the speed of the grid, and if used, the exposure must be made while the grid is moving.

The most serious objection that can be offered to the use of this arrangement is, that it places grounded metal beneath the patient. However, since Bucky exposures are made with the tube at a greater than average distance from the film, and thus at a greater distance from the patient, perfect safety would generally be insured. So it seems that under the circumstances of its special purpose, the added convenience afforded by this device would permit us to use it, even though grounded metal beneath the patient is to be ordinarily avoided.

I wish to acknowledge the assistance given by Mr. J. M. Blake, the chief engineer at St. Bartholomew's, and to thank him for building the switch that I am now using.

A NOTE ON THE USE OF THE BUCKY-POTTER DIAPHRAGM WITH THE FLUOROSCOPE

BY WALTER C. ALVAREZ, M.D.

SAN FRANCISCO, CALIFORNIA

WHEN the great efficiency of the Bucky-Potter diaphragm became apparent two years ago, a few manufacturers supplied grids for use on fluoroscopes. I tried one for a while and then gave it up because the shadows of the lead strips bothered me and cut out so much of the light.

A few months ago there appeared the paper of Wilsey,[1] who showed that the efficiency of these diaphragms depends largely on the closeness of the photographic plate to the grid. It immediately occurred to me that a high degree of efficiency in the fluoroscope might be obtained by removing the calcium tungstate screen from its position next to the lead glass window, and fastening it closely to the convex surface of a grid placed just behind that window. This was done, and the screen surface was protected from dust and dripping barium by a thin cover of celluloid (a 14 × 17 film with its emulsion removed).

The results obtained have been most satisfactory, and I would not now think of parting with the apparatus. Even in stout people the abdominal organs show up much as they do in a good plate. Strange to say, the grid hardly shows at all. It is troublesome only when one is looking at the chest. Some light is, of course, cut out by the apparatus, but this loss is more than compensated for by the great increase in definition at the edges of the barium shadows. Furthermore, I find that I can use with advantage a much higher spark-gap than ever before. This gives better penetration in cases of stout people, without any of the fogging which formerly increased as fast as the voltage was raised.

The only objection I now have to the grid on the fluoroscope is that when paldating the abdomen one has to be so careful to keep the screen from rotating slightly on a vertical axis. Such rotation naturally shuts off almost all the light.

The more recent work of Wilsey[2] shows that an efficient grid can be made .16 in. deep with lead strips .01 in. thick and gaps .05 in. wide. It seems to me that the use of such a delicate grid, with the fluorescent screen closely applied, would bring the radioscope very close to perfection.

---

[1] WILSEY, R. B. The efficiency of the Bucky-diaphragm principle AM. J. ROENTGENOL., 1922, IX, 58.

[2] WILSEY, R. B. Some practical results with a Potter-Bucky diaphragm. AM. J. ROENTGENOL., 1922, IX, 441.

THE EFFECT OF THE WAR ON THE DEVELOPMENT OF ROENTGENOLOGY*

BY PRESTON M. HICKEY, A.B., M.D.

ANN ARBOR, MICHIGAN

IT IS always interesting to devote some attention to history. At the time history is being made, it is difficult to get any other viewpoint than that afforded in one's own immediate environment. It is necessary to wait for the perspective imparted by lapse of time to appreciate properly the various forces which are active, and to estimate their ultimate value to man.

If too much time is allowed to elapse before this historical study is made, the picture is frequently falsified by lack of knowledge of what actually took place. It is our belief that the popular historian is very rarely an accurate one.

It therefore seems to us timely to study some of the phases of roentgenology presented by the Great War, and to trace some of the after-influences as we now have the privilege of seeing them.

In 1914, the art of the roentgen rays was not quite past its second decade. Its applications had been limited principally to civil life. There had been no true opportunity to test the usefulness of the rays in military surgery, and comparatively little had been written about the uses which had been made; with the notable exception of the work published by the Surgeon-General's office, under the immediate direction of Colonel Ford, there was little literature to which one could turn.

There was, then, in 1914, presented a phase in medical history which was practically without precedent. There arose the opportunity for the medical profession to make use of a new discovery whose practical applications were of the utmost importance from a surgical and medical standpoint. When we think back and realize how quickly the new art was developed in its new applications from a military standpoint, we can again congratulate ourselves on belonging to probably the most progressive of all professions.

The French and English, although they attempted at once to make the most liberal use of the roentgen rays in their military hospitals, found themselves confronted with the great problem of supplies. In France, there was no time to develop factories; the lack of men, who were all needed in the army, the difficulty in obtaining materials, the suddenness with which the necessity arose, all combined to make the extensive use of the roentgen rays difficult. In order to supply the French army, practically every type of private *x*-ray outfit was taken over by the authorities and placed at the disposal of the military surgeons. The English were in a particularly unfortunate position, owing to their short-sighted policy of free trade. The English manufacturers of *x*-ray apparatus had never received any encouragement from their government, and, being placed in competition with German and French manufacturers, had, at the beginning of the war, not obtained any degree of manufacturing importance. Consequently, when the English authorities attempted to supply the demands of the English military surgeons, they found the greatest difficulty in manufacturing *x*-ray supplies. The English military hospitals were handicapped all through the war by the lack of *standardized* equipment. The wonderful way in which they "carried on," however, under such trying circumstances, is a matter of congratulation.

We feel proud of the way in which our American roentgenologists who were aiding the British in 1915 and 1916 did their part. Among the few names which I might mention are those of Walter Dodd, A. H. Pirie, and Percy Brown, whose fame will be lasting.

Even after it was apparent to the average reader of the daily newspaper that the United States would ultimately be drawn into the war, valuable time was apparently lost which could have been spent in preparation for the inevitable conflict. It was, perhaps, difficult for the

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

Surgeon-General's office, without authorization and appropriation from Congress, to take the initiative in planning and preparing for the *x*-ray needs of a great army.

However, when the decisive step was taken, the roentgenologists of the country, through their active cooperation, helped to make up for the time that had been lost, and by their enthusiasm and self-sacrificing patriotism performed their allotted tasks in a manner of which we can well be proud.

Very early in these preparations, it was definitely realized that only by standardization of methods of education and the adoption of uniform standardized types of apparatus could the work be successfully carried out. Fortunately, the manufacturers of this country had been favored by the government, so that they were in much better shape to undertake their tremendous task than had been their English and French brothers.

It would be useless, or perhaps I should say needless, to enumerate the various difficulties which were surmounted, as many of you are familiar, from your own experience, with the way in which the situation was handled. I think it can be said without exaggeration that no branch of the medical service of the army furnished more satisfactory and complete assistance than did the Department of Roentgenology. The American soldier, when wounded, and in need of rapid and accurate localization of bullet or shrapnel, was carefully and expeditiously cared for, and the American soldier, when ill, was taken care of by a medical department which always had the assistance, when desired, of a well-equipped *x*-ray laboratory.

It is a matter of congratulation to us, as members of this great specialty, to feel that the *x*-ray examinations, as demanded by military exigencies, were always available, and were completed in a manner which compared with any other department in the medical service.

From the fact that the *x*-ray work furnished to the army was highly satisfactory, there has resulted a great stimulus to *x*-ray work in general. It will be our pleasure to discuss for a few moments some of the various results which followed the war.

In the examination of the recruits for the Mexican campaign, in 1916, comparatively little was done with *x*-rays except as certain isolated and special cases might require.

With the beginning of the recruiting service for the Great War, there developed a conviction that the *x*-ray examination of the chest, somewhat superficial though it might be, in view of the thousands of men to be looked over, was an important factor in the weeding out of the physically unfit, and that with its use could be detected obscure pulmonary conditions which might become grossly exaggerated under the trying experiences of an active campaign. The work of Cole, Dunham, and others demonstrated most effectively that it was possible to examine quickly large numbers of men and make *x*-ray plates of their chests, and that the additional expense was amply justified by the saving to the government in suitably classifying those whose pulmonary pathology was important, if not always evident.

It is, perhaps, hard to realize the far-reaching effects of such a procedure in popularizing with the internist the routine *x*-ray examination of the chest. The army surgeon, recruited from the ranks of the civilian practitioner, had not been in the habit of considering the roentgenograph of the chest as an important routine procedure. However, when, in the pursuance of his military duties, he found at his elbow a well-trained roentgenologist, with a comparatively well-equipped laboratory, he became accustomed to rely for the confirmation of his opinion on the intelligent interpretation of the pulmonary plates. When confronted with large numbers of cases of pneumonia, he began to realize that the well-interpreted plates had at least equal weight with a careful physical examination of the chest. One of the great factors in this change was the ease with which *x*-ray examinations could be obtained, without considering the cost in dollars and cents to the patient. Where previously he had found it necessary to consult with the patient as to whether the latter was financially able to afford the necessary *x*-ray examination, he found all this changed, and that the simple writing of a request threw the financial burden on the government. If the internist were attached to a base hospital receiving hundreds of patients with the accompanying perplexing questions of diagnosis, he found that the simple request for an *x*-ray examination of the chest or of the gastro-intestinal tract would give him, not merely assistance in making up his mind as to the presence or absence of decided pathology, but that often the final word in the diagnosis would be furnished by the *X*-ray Department.

We think we can safely say that the average internist, during his military service, became rapidly educated to seek the assistance of the roentgenologist and the roentgen laboratory in a manner to which he was, indeed, before a stranger.

In looking over the statistics of *x*-ray departments in different parts of the country, we are struck by the great increase in the number of examinations which were made in the year 1918. This, we think, is largely accounted for by the fact that the returned military surgeons, when re-entering civil practice, continued their habit of seeking aid from the *x*-ray laboratories.

Not only did the military surgeon become rapidly accustomed to a more liberal employment of these examinations, but the returned soldier, when confronted by illness of himself or of his family, frequently suggested the use of *x*-rays to which he had become accustomed during his time of military service.

Hospital superintendents and members of hospital boards, from their experience with army necessities, have come, we think, to adopt a much more liberal policy than formerly with regard to the planning of *x*-ray laboratories in our various hospitals. Before the war, the favored place for the *x*-ray laboratory, according to the hospital superintendent's idea, was the basement, next door to the coal cellar or the laundry. A gradual improvement has been noticed in the location of *x*-ray laboratories, and a more liberal policy has been established with regard to the equipment of the same.

We believe also that this same increase of liberality has extended to the recompense for the work done. The salaries of roentgenologists have been increased, and in many cases the work has been placed upon a profit-sharing basis.

On account of the changed attitude of the profession and of the patient, *x*-ray laboratories in hospitals have been placed on a self-sustaining basis, and, in many instances, have become a distinct source of revenue to the finances of the hospital.

It is significant, also, to note that one of the requirements for an A class hospital is a well-equipped and properly manned *x*-ray laboratory.

The rapidly extended use of *x*-rays in war time introduced many physicians to the specialty, and after the war was over, there was observed a large increase in those who specialized in *x*-ray work. Many found places in the newly-developed clinics which rapidly arose in different parts of the country, and many opened offices, either as part-time or full-time roentgenologists. While some of these were only imperfectly fitted for their new specialty, the law of the survival of the fittest has either spurred them to diligent study or has weeded them out.

The influence of the war on the manufacturers of *x*-ray apparatus has also been very striking. On account of the large number of new roentgenologists, manufacturers have been kept quite busy, and the steady demand for their wares has enabled them to follow along lines of quantity production with well-standardized equipment. When one compares the American manufacturers with those abroad, he realizes that the former have fallen quickly in line with quantity production of standard quality, so characteristic of American manufacturers. At the present time one feels that money invested with any reputable American manufacturer will be exchanged for apparatus of a standard type.

In this hasty survey of the situation, it would be amiss not to mention the rapid development of so-called portable units since the war. Formerly our portable work was done with the dress-suit-case type of the high-frequency machine, without meters and without a precise technique. Formerly only the more simple types of examinations were feasible; now with the modern portable machine, plates are obtained of a quality comparable with those made by a well-equipped laboratory.

It is quite fitting at this juncture to recall the painstaking, resourceful work which was done in the development of the portable outfit by our lamented friend, Professor Shearer. It is only when we place side by side the old model of the portable outfit with the present highly-developed model that we realize the developmental work which was done. Certainly none of the work, varied and extensive though it was, that Professor Shearer accomplished during his fruitful life was more productive of real practical results than the perfection of the bed-side unit.

On account of standardized methods in the army school and in army practice, the Coolidge tube has become even more popular and useful than before. Its wide popularity has resulted in a more uniform technique, which has steadfastly raised the general standard of excellence of plates. It is interesting to visit different laboratories and see the uniform excellence of work which is now being done, owing to a standardized technique.

A more liberal use of fluoroscopy in the removal of foreign bodies is also traceable to the army training. No longer is the hand or foot extensively mutilated in long-continued efforts to find a needle or a bullet. Operation under fluoroscopic control is now perfectly safe by the intermittent method, and results in easy removal, with a minimum laceration of the tissues.

The extensive use of the fluoroscope in the manipulation and control of fractures is also a step in roentgenologic progress.

Another outcome of the development of war activities has been the diminution in the size of machines. With the self-rectifying tube and the bed-side type of transformer, the internist is now able to do adequate fluoroscopy and still not encroach on valuable office space. In planning or installation of *x*-ray outfits in buildings where the price per square foot is high, this constitutes a very important item. Practically very little floor space is needed for the electric part of an *x*-ray outfit.

It is interesting to note also the large number of internists who have placed fluoroscopes in their offices, not with the idea of specializing in *x*-ray work, but simply wishing to have conveniently at hand an *x*-ray control of their physical findings. Here again, the simplified apparatus which has developed from war-time practice is conspicuous.

The problem of glass plates, their weight, and inherent danger of breakage, caused all who had to deal with military *x*-ray supplies to welcome the *x*-ray film. A cursory survey of the different laboratories in the country shows that the film has replaced the plate in practically every laboratory.

The ability to mail films has been a great saving to patients and has been of much practical value in the referring of cases to different parts of the country.

In no other branch of *x*-ray development has there been greater progress than in literature. Before the war, American *x*-ray literature languished, overshadowed by the work of more prolific writers from across the water. Since the war, however, American *x*-ray literature has come into its own; our *x*-ray journals have increased in size, quality and circulation; many books have appeared which are a credit to their writers, and we can point to them with a feeling of national pride. The large number of workers naturally furnishes a good market, which in turn encourages production.

Our society should foster in every way this outcome of the war, and not allow foreign publishers again to monopolize the field. The opportunity came and was seized upon; let us not now lose it.

With this advent of standardized technique, we must not forget that we should turn our attention to standardization of methods of roentgenologic teaching, and that we should urge upon the different medical colleges of the country the necessity of a more uniform curriculum in *x*-ray work. It is undoubtedly true that there is coming a period of readjustment in methods of medical education. There is a feeling that there is too much memorizing of known but infrequently applied knowledge. The type of instruction must change from the highly theoretical to a more practical cast. If we do not insist that our own specialty receive proper recognition, it may happen that the change in the curriculum which will soon come about, will not accord to roentgenology its proper place. We, accordingly, as a well-recognized and influential society, should seek to extend these post-war influences, so that they may be perpetualized through proper medical education.

In conclusion, it may be said that the sacrifices and hard work of the roentgenologists during the war have not been without reward in a great broadening of the field of roentgenology, and that any survey like this, however incomplete, can only be made with satisfaction that the work has been so well recognized.

DISCUSSION

Dr. Christie. I have practically nothing to add to Dr. Hickey's very timely paper. It seems to me it is a very timely paper, because it brings to us a resumé of the things that happened during and since the war. Many of us had great misgivings during the war about what was to happen to roentgenology as a specialty because of the great number of men who had to be trained for *x*-ray work during the war. It seemed that the small amount of training that so many men received would turn loose on the country very many poorly-prepared men. This misgiving was not very well founded, because those who were not well trained, and who had little ability for advancement in this specialty have dropped out. There have been added to the specialty a very great many well-trained and excellent men. There are one or two points I wish to emphasize in Dr. Hickey's paper: One point that especially appealed to me is that the *x*-ray work in all our hospitals in the army did bring to the internist and surgeon appreciation of *x*-ray work which they never had before. It is certainly so in my own city. Very many men who knew nothing at all of the value of *x*-ray work before the war, came back after the war, and appreciated the value of this work. Besides that, it has a great influence in helping to stamp out, to some extent, the commercial laboratory, because the men who served in good post-hospitals during the war found out what good *x*-ray work was and were able to discriminate between the two. For that reason they are coming to men who are well-qualified roentgenologists. I believe with Dr. Hickey that the general effect of *x*-ray work during the war has been for the good of our specialty, and medicine in general.

Dr. Pirie. First of all, I wish to agree with Dr. Hickey on the effect of the war on the development of *x*-rays. It has popularized *x*-rays and has given us a great deal more to do. I looked for great developments from the war, and I found none. The great development is the popularity of the *x*-ray now, in comparison with what it was before. One development which has arisen and which I did not foresee, and is only coming now in my practice, is this: The army files which kept the history sheets were big folders; we use similar folders in hospitals in Canada, and since the introduction of films, I file the films away with the medical history in these folders, so that at any future date when I want the films, I get with them the complete history of the case. It is also an easy way of disposing of films.

I am going to disagree with Dr. Hickey in his statement that the short-sighted policy of the English did not supply good apparatus. Now, a good many of you do not know what the English did in the *x*-ray world. I saw 2,000 *x*-ray tubes waiting to be sent to France. We never failed to have *x*-ray plates when we wanted them. The apparatus we had did the work, and that was what we were after—to localize the foreign bodies and get the boys back to the front as soon as possible. No man was burned by the English apparatus during the war. Although we did not have extremely fine apparatus, it was war, and we wanted apparatus that would do the work.

Dr. LeWald, of New York, showed some lantern slides, and called attention to the work of the late Dr. E. W. Caldwell, and asked Dr. Hickey if any further development had followed in the use of the Caldwell Stereo-fluoroscope, and the bakelite canvas stretcher top. Dr. LeWald referred to the work of the late Prof. John S. Shearer and his associates, especially that of Captain Middleditch; and of the large number of roentgenologists (nearly three hundred) instructed in the New York School of Military Roentgenology, many of whom were present. He referred to the work of the instructors who remained in this country, and considered the relative importance of their work as essential to the winning of the war.

Dr. LeWald wishes to emphasize what Dr. Hickey said relative to the importance of the proper teaching of roentgenology in the Medical Colleges, as, otherwise, the full effect of the marked stimulus which resulted from the war might be lost.

Dr. Manges. I am sure we have all enjoyed Dr. Hickey's paper. Only Dr. Hickey could write a paper like this, and if we take the time really to study what he has said (and we cannot get it from just sitting listening to it) we will find that it has a great deal of interest for all of us. I have only a few words to say in discussion, and those because his paper has brought back to me impressions that I have had since the war has closed.

In the first place, there has been an increasing demand for instruction. More and more men are applying to the larger clinics for advanced instruction. I know that, because in the last few years I have had to turn away numbers of men who wanted instruction of one kind or another. I was so situated that I could not take care of many of them, and I have no doubt there are others with the same experience. Some of these men wanted to come for a term of months, or even for a full year. Just this one fact alone emphasizes what Dr. Hickey brings out in his paper—that is, the tremendous effect the war has had on our specialty.

Then there is another fact of importance: There is an increasing demand for trained or experienced roentgenologists. I have numerous letters on file, asking me to recommend such men for good positions. I have not been able to supply them, for the very good reason that every well-trained man is already established.

There is still another impressive fact. Before the war, our work came to us largely from the older and more established members of our profession, whereas now, a great deal of it comes from the young surgeons and internists who were in the service. Our clinics and laboratories are simply overwhelmed with requests for the study of the sinuses, chests, urinary and gastrointestinal tracts, and of all other parts of the body. These men learned during their service to depend a great deal upon the diagnostic aid of the roentgenologists of their organizations. Many of them had to face problems in camp life in this country, as well as at the hospitals near the front in Europe, such as they had never experienced in civil practice. In most of the camps there were epidemics, and in all of them there developed conditions in the chests of many of the officers and enlisted men who were brought from sedentary and more or less inactive lives into new surroundings, and were put to unusual exertion, so that many of them developed bronchitis or some degree of bronchopneumonia; others suffered from dilatation of the heart and a certain degree of pulmonary congestion. It was demanded of them that an early diagnosis be made, and they learned to depend a great deal upon the *x*-ray department—especially to rule on the question of pulmonary tuberculosis. Many officers and men who were suspected of being tuberculous cases returned to normal with rest after negative *x*-ray diagnoses. Now all those clinicians and internists are our warmest friends, and they are depending more and more on us to confirm or refute their diagnoses as to chest and other conditions.

I wonder if all of you really appreciate the amount and value of the teaching that was done during the war. Those of us who were actively engaged in it realize that we were trying to do something big, and if we did accomplish something—and I believe we did—it was largely due to the master-mind of Shearer, who was a born teacher and who knew our problems from A to Z, especially the electrical and mechanical problems. He directed every bit of the technical teaching that was done, that was of any value, during the war. We did not teach our individual ideas or hobbies. There was no place for that. Shearer had that insight as to what was needed, and after a little conference in New York, before we got actually started, we had practically mapped out the line of work that was to be carried out. I am sure that that teaching has had wonderful effect on the future of roentgenology. As to Dr. Hickey's recommendations for future teaching in the undergraduate schools, I think there is a great deal of thought to be given to that, and I am not prepared to discuss it any further.

Dr. Hickey (closing discussion). One thought was prominent in writing this paper: that when the Americans entered the war, they had the advantage of using standardized apparatus for *x*-ray diagnosis. I think it can be considered as settled beyond discussion that a military hospital which has the advantage of standardized *x*-ray apparatus will, in general, turn out better work than one not fitted with standardized apparatus.

It is to be hoped that out of this discussion will come a stimulus to our publication committee to elevate our journal in every possible way, so that it will be the leading roentgenologic publication in the world.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. · H. K. Pancoast, M.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

FOURTH ANNUAL MEETING EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY

RITZ-CARLTON HOTEL, ATLANTIC CITY, N. J., JANUARY 25–27, 1923

MIDWINTER MEETING CENTRAL SECTION AMERICAN ROENTGEN RAY SOCIETY

SEELBACH HOTEL, LOUISVILLE, KY., FEBRUARY 24, 1923

CORRESPONDENCE

To The Editor:

In your April, 1922, issue, p. 247, Prof. Hazen has the following remark:

"At the present time I should be much inclined to feel that superficial cancers will yield much more rapidly to unfiltered than to filtered doses and that the very powerful types of apparatus that are now being developed will have no effect upon the prognosis of skin cancer."

This is not my experience. I irradiated a patient with rodent ulcer extending from the inner canthus of one eye to that of the other. Almost all of the nasal cartilages were eroded. Exposure, on July 20th last, to 60 minutes, 5 ma., 200,000 volts, filter 1.3 mm. Cu., and 1 mm. Al., skin-target 50 cm., led to prompt healing. The ulceration over the cartilages healed at once, the mucous membrane growing over it without any delay. The dose has been repeated only once (on Sept. 8th).

Yours faithfully,
H. Flecker.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page i of this number of the Journal. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to Roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

The meeting of the Eastern Section at Atlantic City promises to be of considerable interest, judging from the following preliminary statement.

PRELIMINARY PROGRAM OF MIDWINTER MEETING EASTERN SECTION A. R. R. S.

Thursday, Jan. 25, 8:15 p.m.

Localization of Brain Tumors by Cerebral Pneumography. Dr. Walter Dandy (By invitation), Baltimore, Md.

Discussion to be opened by Dr. Harry C. Kerr (By invitation), Washington, D. C., Dr. Foster Kennedy (By invitation), New York City, N. Y. and Dr. H. K. Pancoast, Philadelphia, Pa.

Friday, Jan. 26, 9 a.m.

Some Preliminary Observations on Cardiac Measurements in Children. Dr. F. S. Borzell, and Dr. Ralph M. Tyson (By invitation), Philadelphia, Pa.

Discussion to be opened by Dr. H. K. Pancoast, Philadelphia, Pa.

Stereoscopy of the Accessory Sinuses. Dr. G. W. Grier, Pittsburgh, Pa.

Discussion to be opened by Dr. F. M. Law, New York City, N. Y.

Para-Articular Tuberculosis. Dr. Lawrence Reynolds, Detroit, Mich.

Discussion to be opened by Dr. Leon LeWald, New York City, N. Y.

Osteitis Fibrosa Cystica. Dr. Percy Brown, Madison, Wis.
Discussion to be opened by Dr. F. H. Baetjer, Baltimore, Md.
A New Tube Holder for Deep Roentgen Therapy. Dr. Edwin A. Merritt, Washington, D. C.
Discussion to be opened by Dr. W. H. Stewart, New York City, N. Y.
Roentgen Diagnosis of Deep Cervical Glands. Dr. Lewis G. Cole, New York City, N. Y.
Discussion to be opened by Dr. W. F. Manges, Philadelphia, Pa.
Roentgenographic Studies of Abscess of the Lung Treated Successfully by the Bronchoscopic Method. Dr. W. H. Stewart, New York City, N. Y.
Discussion to be opened by Dr. Leopold Jaches, New York City, N. Y.

FRIDAY, 2 P.M.

Secondary Signs of Gall Bladder Pathology. Dr. Ralph D. Leonard, Boston, Mass.
Discussion to be opened by Dr. Lewis G. Cole, New York City, N. Y.
Diagnosis of Obscure Abdominal Lesions by the Routine Gastro-Intestinal Examination. Dr. W. H. Dickson (By invitation), Toronto, Ontario.
Discussion to be opened by Dr. G. E. Pfahler, Philadelphia, Pa.
Further Studies in the Biology of Cancer Cells. Dr. Francis C. Wood (By invitation), New York City, N. Y.
Discussion to be opened by Dr. James Ewing (By invitation), New York City, N. Y.
Measurement of Dosage by Means of Ionization Chambers. Dr. William Duane (By invitation), Boston, Mass.
Discussion to be opened by Dr. Otto Glasser (By invitation), Baltimore, Md. *On Dosage Problems.*
Measurement of Ionization Produced by Scattered and Secondary Radiation Which is Effective in Producing an Erythema. Eugene Leddy, M. D., and J. L. Weatherwax, M. A. (By invitation), Philadelphia, Pa.
Discussion to be opened by Mr. G. Failla (By invitation), New York City, N. Y.

FRIDAY, 8: 15 P.M.

The Diagnosis of Bone Tumors Based upon the Clinical History, Examination, X-ray and the Pathology as Exposed by Operation. Dr. Joseph C. Bloodgood (By invitation), Baltimore, Md.
Discussion to be opened by Dr. James Ewing (By invitation), New York City, N. Y., and Dr. F. H. Baetjer, Baltimore, Md.
Lantern Slide Exhibit

SATURDAY, JAN. 27, 9 A.M.

Statistics and Technique in the Treatment of Prostatic Hypertrophy by Means of the Roentgen and Radium. Dr. J. T. Stevens, Montclair, N. J.
Discussion to be opened by Dr. J. T. Geraghty (By invitation), Baltimore, Md.
Systemic Effects of Deep Roentgen Irradiation. Dr. James T. Case, Battle Creek, Mich.
Discussion to be opened by Dr. J. M. Steiner, New York City, N. Y.
High Voltage Roentgen Therapy in the Treatment of Carcinoma of the Breast. Dr. G. E. Pfahler, Philadelphia, Pa.
Discussion to be opened by Dr. Samuel Stern, New York City, N. Y.
The Treatment of Carcinoma of the Floor of the Mouth. Dr. Douglas Quick, New York City, N. Y.
Discussion to be opened by Dr. G. E. Pfahler, Philadelphia, Pa.

SATURDAY, 2 P.M.

Treatment of Carcinoma of Esophagus by Deep X-ray Therapy. Dr. Alexander Pirie, Montreal, Canada.
Discussion to be opened by Dr. J. M. Steiner, New York City, N. Y., and Dr. James T. Case, Battle Creek, Mich.
Results Obtained by Radiation (Radium and Roentgen Rays) in Malignancy of the Prostate and Bladder. Dr. J. T. Geraghty (By invitation), Baltimore, Md.
Discussion to be opened by Dr. H. G. Bugbee (By invitation), New York.
A Review of the Treatment of Hyperthyroidism by All Methods with a Résumé of the Authors' Experience with Roentgen Therapy. Drs. Thomas A. Groover, Arthur C. Christie and Edwin A. Merritt, Washington, D. C.
Discussion to be opened by Dr. George E. Pfahler, Philadelphia, Pa.
Business Meeting.—Election of Officers.
Annual Meeting of the Military Roentgenologists.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

THE PHYSICAL AND TECHNICAL FOUNDATION FOR THE MEASUREMENT AND DOSAGE OF THE ROENTGEN RAYS, by Frederick Voltz. Supplement VI to *Strahlentherapie*, with 173 figures. Berlin, Vienna, Urban & Schwarzenberg, 1921.

This volume, consisting of about 300 pages, gives an exhaustive presentation of the physical nature of the roentgen rays, their measurement and dosage. The book is primarily intended for the physician, for the technician and for all those who work with *x*-rays. However, it presents a good amount of mathematical physics for the practitioner, so that he has to select the matter which interests him theoretically, and which is important for him practically.

For the purposes of this review, a few of the conclusions which are valuable for practical therapeutics have been selected. As direct measuring methods of the quantity of the roentgen rays, (1) the iontoquantimeter and (2) the selenium cell (Fürstenau intensimater) are of practical value. The first is also applicable for scientific purposes and for comparative tests, and gives the most reliable results. In the iontoquantimeter, the *x*-rays ionize the gases in a graphite chamber; through the ionization an electrometer connected therewith is discharged; the time of discharge is the measurement for the quantity of absorbed roentgen-ray energy. The unit of measure for the quantity of electricity generated in the chamber is "e" (Friedrich); its dimension is $\text{cm.}^{3/2} \times \text{g.}^{1/2} \times \text{sec.}^{-1}$. With this unit, a capacity of 1 cm. to 300 volts can be attained. The selenium cell of the Fürstenau intensimeter has the defect of selective absorption, which, however, is of little importance in the practical measuring of intensity and surface energy. This defect is still less important, because, in practice, the bundle of roentgen rays is filtered and the maximum of intensity is consequently shifted over to the region of the short wave-lengths which lie beyond the absorption band of selenium. For that reason, the selenium cell can very well be employed for the purpose of comparing intensities, provided the conditions of roentgen-ray generation and the apparatus remain the same. To employ quantimetric and qualimetric methods at each irradiation is too cumbersome for the determination of the *x*-ray dose. Seitz and Wintz have therefore introduced irradiation according to time into roentgen therapy.

The mixture of rays of a roentgen tube is first measured quantitatively and qualitatively with some measuring device (most frequently the iontoquantimeter). For practical operation, the following factors must remain the same: (1) Tension on the line (voltmeter); (2) primary self-induction (measure of the degree of voltage); (3) the number of turns of the interrupting motor (tachometer); (4) secondary voltage (parallel spark gap measure of hardness of tension); (5) intensity of the secondary current (milliampère meter).

The radiation from the tube must be tested at definite intervals.

As a unit, is assumed the skin erythema dose (H.E.D.), or that quantity of rays which causes a slight reddening of the skin after eight days and a slight bronzing of the skin after fourteen days.

Provided the above-mentioned conditions are observed, H.E.D. is always obtained in the same space of time.

The skin erythema dose, H.E.D. which equals 100 per cent, must be brought into definite relation with Friedrich's electrostatic unite:

Skin erythema dose = 100% H.E.D. = 170 e.
Castration dose = 35% H.E.D. = 58 e.
Muscle dose = 180% H.E.D. = 306 e.
Intestinal dose = 135% H.E.D. = 230 e.

(The carcinoma dose = 110 per cent H.E.D. and the sarcoma dose = 70 per cent H.E.D. are not accepted as sufficiently established.)

The biological measuring method according to Jüngling seems destined to play an important rôle as a control of the physical measurements. Jüngling irradiated the germinating sperms of the vicia faba equina from the first to the second day of germination. He observed the injury caused by the irradiation and gave the following conclusions: (1) Arrest of growth after forty-five days without the formation of lateral radicles = H.E.D. = 100 per cent; (2) appearance of the lateral radicles at the tip of the radicles, dose = 60 to 85 per cent; (3) appearance of the lateral radicles in the center, dose = 40 to 53 per cent; (4) a delay of two days in the appearance of the lateral radicles, dose = 33 per cent; (5) no delay, dose up to 13 per cent.

A definite temperature (thermostat) is essential for working with this method.

TRANSLATIONS & ABSTRACTS

PETERSEN, WILLIAM F., AND SAELHOF, CLARENCE C. Roentgen-Ray Stimulation of the Pancreas in Experimental Pancreatic Deficiency. (*Am. J. M. Sc.*, Mch., 1922, clxiii, 3, 391.)

With roentgen stimulation of organs two distinct methods may be considered. The first would include the stimulation of dys- or hypofunctioning organs with the purpose of restoring function to the normal. The treatment of anuria in acute parenchymatous nephritis; hepatic intoxication in some forms of cirrhosis; achylia; anemia of certain types; particularly, endocrine disturbances—the ovaries in some forms of amenorrhea, the testicles, the hypophysis in growth disturbances, the adrenals in Addison's disease, the pancreas in diabetes; all these are examples of possibilities of the first method.

The second method includes the stimulation of normal organs and the augmentation of the serum enzymes, thromboplastic substances, antibodies, etc., therewith bringing about therapeutic effects on systemic or localized infections or other pathological processes. With this end in view experiments were conducted on partially depancreatized dogs and the following conclusions were drawn from the work.

In experimental pancreatic deficiency due to partial pancreatectomy, roentgen irradiation of the pancreatic rest may be followed by (*a*) a transient increase in sugar output, then by (*b*) an increase in carbohydrate tolerance. This latter may occur without the preliminary increase in sugar excretion, and the increased tolerance which may be transient or may extend over a period of several weeks after irradiation, therefore, not be due to the preliminary increase in sugar elimination. When increased sugar elimination is brought about by some other irritant (turpentine abscesses), no increase in carbohydrate tolerance is later observed.

The effect on the blood sugar varies. Usually a temporary increase in the blood sugar can be determined, followed by a lowering of the level from five hours to several days after the irradiation. When evidences of acidosis exist at the time of irradiation they may diminish or disappear with the improvement in the sugar tolerance.

The effect of irradiation of the pancreas is due to direct stimulation of cellular metabolic processes and not due solely to alterations primarily vascular. This stimulation is merely an example of the Arndt-Schulz observation that cell irritants in small doses stimulate metabolic processes. When the irradiation is used in too large a dose, injury to the pancreatic function is apparent in a diminution in carbohydrate tolerance. When tissues other than those containing the pancreatic remainder are irradiated, no effect is observed on the carbohydrate tolerance, other than the primary augmentation of sugar excretion. The titer of the serum diastases, which may be altered by irradiation of the liver, seems to be without influence on the tolerance.

HERRMANN, GEORGE R., AND BURROWS, MONTROSE T. A Hitherto Undescribed Tumor of the Base of the Aorta. *Arch. Int. Med.*, March, 1922, xxix, 339.

Tumors of the heart are very infrequent. Tumors of the aorta are even more rare. The tumor described took origin from the aorta and was attached to the heart.

A detailed history of the case is given, together with the roentgenographic findings. A 7-ft. roentgenogram of the heart showed a large, sharply-outlined circular shadow projecting to the right of the midclavicular line. The cardiac dimensions showed a marked enlargement of the right side of the heart. The autopsy findings were as follows:

"Heart: The organ is greatly enlarged, and a large tumor mass, the size of a large orange, is attached to the superior wall of the right auricle, to the tissue of the auricular septum, to the sides of the aorta and pulmonary artery. The attachments to the aorta and pulmonary artery are loose. The firm attachment is to the auricular wall. The fibrous tissue of the pericardium of the heart is continuous with the tumor. The muscle of the auricular wall beneath the tumor is atrophic and apparently not continuous with it. The attachment to the auricle does not appear to be a primary one, but secondary to the irritation of the tumor lying on the auricle. The heart with the tumor weighs 945 gm.

"The myocardium of other portions of the heart, aside from the hypertrophy, show nothing of interest.

"Lifting the tumor away from the aorta reveals the outer wall of the pouch, which is seen to be continuous with a tough cylindrical-shaped cord of tissue which passes directly to the wall of the tumor to disappear within it.

"This slender cylindrical-shaped cord is evidently the pedicle of the tumor, and, on close inspection, is found to be composed externally of a tough gray tissue like that of the aorta or one of the large arteries. It has, however, no evident open lumen, but its center is composed in places of a gelatinous, and in other places of a glistening gray, material. It measures 4 cm. long and ½ cm. in diameter. It looks like an occluded anomalous arterial branch.

"The tumor is ovoid in shape and measures 12 × 9 cm. It has a tough, hard outer wall and is filled with a greasy, necrotic material which everywhere glistens as if it contained crystals. A smear of this necrotic material shows large numbers of rhombic plates with notched corners. The outer tough wall is thickened at this point of insertion of the pedicle. Here there is a large necrotic fragile nodule which extends into and replaces a part of the soft greasy material.

"The remainder of the wall is thin. It measures from 1 to 2 mm. in thickness. This wall is seen to be divided into several layers: an outer one, resembling muscle in many places, a second fibrous-looking layer, and an inner layer which is in contact with the glistening greasy content. This last layer appears to be composed of a gelatinous material which in places is streaked and mottled with gray and yellow opaque lines and splotches.

"From the gross description alone it was evident, therefore, that the tumor was not of auricular, but probably of aortic, origin. It had arisen from an anomalous arterial-like branch of this vessel."

STEIN. Roentgen Treatment of Condylomata Acuminata. *Wien. klin. Wchnschr.*, 1921, No. 26.

In view of the fact that surgical treatment is not satisfactory in cases of broad, large condylomata acuminata, and that recurrences are frequent, Stein irradiated 14 cases of giant condylomata: of these he cured 6, and improved 5 considerably; but 2 cases were not influenced at all. The rapidly growing, cauliflower-like condylomata react promptly to irradiation. Smaller warts, occurring in groups, are resistant to irradiation. In contradistinction to other authors who employ hard radiation with zinc filters, Stein uses only 3 mm. Al. filters and irradiates once or twice, at intervals of six to eight weeks.

ADLER. Radiation of Carcinoma of the Uterus. *Wien. klin. Wchnschr.*, 1921, No. 26.

Even with radium treatment there is a primary mortality; septic infections occur after the intrauterine introduction of radium. Against exclusive radiotherapy in these cases, must be considered the fact that the patients frequently refuse to continue the treatment because they feel very well. Operation gives better results than radiotherapy, but it has come to the limit of its effectiveness. For this reason, the author recommends postoperative irradiation of these cases, but not radiotherapy in place of operation. He operates through the vaginal route because of the lesser mortality involved, and then he combines radium with *x*-rays. Radium is introduced immediately upon completion of the operation.

JOSEPH. A case of death following pneumoperitoneum. *Berl. klin. Wchnschr.*, 1921, No. 46.

A great many authors report favorable results with pneumoperitoneum, which may occasionally, where adhesions are present, even produce a good therapeutic effect. Least favorable is this procedure in diseases in the true pelvis; very frequently no help in diagnosis was obtained. Regarding accidents: Leschke reports a case of injury to the gut; in peritoneal carcinoma Teubern reports a case of oppression caused by pre-peritoneal emphysema, which extended up to the neck. According to the experience of Biernath, one should wait at least fourteen days after pneumoperitoneum before operating. The simplest technique is that which employs a dull needle with a double bulb, while the air or gas is propelled through a water bottle. Goetze recommends that the patient be placed on the right side and the pelvis be elevated. Under these circumstances the intestinal loops are avoided as they drop to one side following the force of gravity. Author reports one case of death out of a series of cases of pneumoperitoneum. This was caused by an embolus. In all probability there was an injury to the right common iliac artery which was situated right below the thickened abdominal wall, as a result of very marked scoliosis. The author recommends great caution in the employment of pneumoperitoneum in all cases where there are anatomical changes.

MENGERT. Prophylactic Irradiation with High Altitude Sun in Rachitis. *Deutsche med. Wchnschr.*, 1921, No. 24.

In the Municipal Infants' Home at Dresden, 18 nursing babies, in whom rachitis, in all likelihood, would have developed later, were treated prophylactically with artificial high altitude sun. Among these were 10 premature births, 5 suffered from disturbed nutrition, 2 were congenitally luetic and one had been brought up by a wet nurse. Only the latter already showed evidence of rachitis. Irradiation was carried out from the first to the second month. The results after the conclusion of irradiation were excellent. The exceptionally brilliant cure in the almost unavoidable rachitis of premature birth was particularly striking. The clinical observations were controlled by roentgen examinations. Technique of the treatment: 30 irradiations in all, each irradiation followed by an interval of two or three days, alternately front of chest and back; in the beginning, three minutes at a distance of one meter. The dose is then increased by three minutes until fifteen minutes are reached, retaining the same distance. After several exposures, the distance is decreased by 10 cm. until 70 cm. is reached. Thereafter, at 70 cm. distance, the time of exposure is again increased by three minutes up to thirty minutes, which is the maximum time of exposure.

RÜPPEL. Hilum Tuberculosis in Adults. *Med. Klin.*, 1921, No. 29.

The general symptoms of tuberculosis of the bronchial lymph-nodes are not characteristic. Percussion and oscultation frequently leave us in the lurch. On the other hand, the *x*-ray findings show, in cases of tuberculosis of the bronchial lymph-nodes, massive changes, and at one stroke clear the picture of the disease. As a matter of differential diagnosis, it is important to bear in mind the swelling of the bronchial nodes which occurs after grippe and continues for some time. Comparative exposures must be made at regular intervals. If one sees some of the enlarged bronchial lymph-nodes disappear after a few weeks, them one can assume that it was a case of grippe.

CAMP, O. DE LA. Radiation Treatment of Tuberculosis. *Med. Klin.*, 1921, No. 48.

The author emphasizes the importance of light for the life of plants and animals, and recalls the light cults of the old nature religions, the helioses of the Greeks, the solaria of the Romans, and the sun-cure mountains of the ancient Germans. The biological effect of the administration of light rests mainly in the skin. The action of the pigment is that of a protector against light, a sensitizer, and transformer of light energy, but also as an accumulator of heat and a regulator of transpirations. In the blood, the effect of light is shown in the increase of the function of hemoglobin, of the oxidizing processes and in lymphocytosis. Metabolism is increased by the effect of light, respiration becomes slower and deeper. Roentgen and radium irradiation cause, in general, the same biological effects. They penetrate, however, more deeply and have a varying effect on the different tissues, the normal as well as the pathological. In the battle with tuberculosis, radiotherapy attempts to assist the body. At all events, it must never do harm. Functional stimulation of tissue may, in general, be considered a process of healing, but the transition from the destruction of tuberculous tissue to the stimulation of the connective tissue is in a state of flux. For that reason, it is wrong to speak of a uniform tuberculosis dose. While in tuberculosis of the skin, local treatment with Finsen and Quartz light should be employed in addition to roentgen and general heliotherapy, the more deeply situated tuberculous lesions of bones, joints and lymph-nodes are treated more successfully with local roentgen and radium radiation than with heliotherapy. In pulmonary phthisis, the roentgen rays are effective in the non-progressive and non-destructive, in the afebrile and not in the pneumonic and exudative forms; but the cooperation of all these curative measures is necessary. In conclusion, the author emphasizes the value of prophylaxis, of the care of the young in the battle against tuberculosis, and prays to Mother Sun to aid us.

SCHWARZ. The Diminution and Increase of Radiosensibility of Animal Tissue and their Importance for Radiotherapy. *München. med. Wchnschr.*, 1921, No. 25.

The author demonstrated, in 1909, that skin which has been made anemic by pressure is considerably less sensitive to *x*-ray and radium irradiation than skin with normal circulation. Per contra, he also reports, that by hyperemia or by inducing inflammation, he has been able to bring about more intensive effects of the roentgen rays, that is, greater sensibility. For that reason, he considers as injurious too large portals of entry or too intensive doses, because they cause injury to the blood and disturb the production of leucocytes. He, on the contrary, wishes to produce a leucocytosis to facilitate the healing of tumors. For this purpose, one may use diathermy (Meyer, Theilhaber, Chr. Müller). Meyer and Behring have demonstrated that testicles of guinea-pigs which have been diathermized, have shown aspermia after smaller *x*-ray doses than those that have not been diathermized. Weinstein has employed, in cases of inoperable carcinoma of the cervix, constant hot vaginal douches in conjunction with roentgen treatment. The author recommends that the early reaction of the *x*-rays should be utilized, because, in his opinion, they represent an expression of the destruction of lymphocytes and tumor cells whose products of disintegration result in chemotaxic inflammation. The total dose should, therefore, be distributed over three days. Furthermore, the author has attempted to bring about specific inflammatory reaction by injection of products resulting from disintegration of tumors, and has seen several astonishingly good results, but also failures.

Borggreves. Roentgen Stereoscopy without Expensive Special Apparatus. *München. med. Wchnschr.*, 1921, No. 47.

Owing to the very high cost of stereoscopic apparatus, the author recommends the following simple method: Stereoscopic exposure is made in the usual manner by shifting the tube 7 cm. for the second plate, but the position of the patient and the focus-plate distance remain the same. Stereoscopic examination is then made by placing one of the exposures with the film side against the illuminating box, the other exposure with the glass side. A very black *x*-ray plate or a glass mirror which has its coating on the anterior surface is held in a sagittal direction in front of the forehead and tip of the nose of the observer. While the right eye sees the right sided exposure without any hindrance, the dark plate or the mirror reflects the left exposure in the reverse order; it must be held in such a position that the reflected image and the normal image overlap each other, producing plastic appearance.

Werner. A Contribution to our Knowledge of the Generative Processes after Radium and Roentgen Deep Therapy. *München. med. Wchnschr.*, 1921, No. 25.

Out of 1,500 women treated by radiation for metrorrhagia or myomata, 17 became pregnant, several of them repeatedly, so that altogether, 24 cases of pregnancy after irradiation were observed. There were 9 abortions (3 of these were unquestionably induced), 14 normal births, and one total extirpation of the uterus on account of myoma. Six women, who for many months had become amenorrheic owing to irradiation, became pregnant again; in the other cases there resulted only oligomenorrhea. Of the 14 children born alive, 4 died, one immediately after birth, 3 at the age of one year from pneumonia or measles. The other children were under permanent observation. Of these, 3, which are now 6 or 8 years old, are 16 per cent below the normal in weight and 8 per cent below the normal in height. Two other cases were irradiated during pregnancy; in the first case, 4 roentgen irradiations were given; the child is normally developed; in the other case, there have been 4 treatments intravaginally with 30 to 50 mg. radium bromide, each treatment lasting twenty-four hours. The child, which was born at term, weighed only 2 kg. and was lacking in fat; its skin was pale yellow; it is now three years old; in height and weight it corresponds to two years, but is otherwise healthy. Irradiation of the ovum or of the embryo may, therefore, cause injury which, however, can be followed by extensive improvement in the course of later development.

Foerster. Clinical and Roentgenological Observations in Cases of Duodenal Adhesions. *Mitt. a.d. Grenzgeb. d. Med. u. Chir.*, 1920, xxxii, Heft 5.

Nine cases showed by history, clinical and roentgenological observations, symptoms which pointed to duodenal ulcer. The roentgen examination revealed always very active peristalsis. The duodenal bulb, in most cases, was very much distended; in 7 cases it showed marked residue after six hrs. It must also be noted that out of these 7 cases, 5 showed also a small residue in the stomach. Marked displacement of the first portion of the duodenum to the right and upward was frequently present. In most instances, the contour of the bulb was ill-defined and showed distinct bulging, twice even after direct filling through the duodenal feeding tube. All 9 cases were operated upon, but in none was a definite duodenal ulcer found, though in all there were fairly marked adhesions around the duodenum. The persistent shadows in the duodenum which had the appearance of niches were found to be projections in the wall. This leads the author to conclude that inasmuch as the entire symptom complex suggests duodenal ulcer, the symptoms mentioned in literature as suggestive of duodenal ulcer, may be caused entirely by adhesive processes. Only 2 of the cases showed primary ulcer; one had hemorrhages several years before; in the other case an old scar was found at autopsy. For this reason, the author leaves open the question as to whether the adhesions are caused by primary processes in the duodenum or by inflammatory processes of the neighboring viscera, for instance, the gall-bladder. Medical treatment was practically without result, but surgical procedure also failed to produce any lasting cure. Four cases examined after operation very soon showed new adhesions and presented old symptoms.

Karshner, Rolla G. *X*-ray of the Heart. "*Southwest*" *Med.*, Oct., 1922, vi, 10, p. 362.

This is a very concise but instructive presentation of the present status of the *x*-ray examination of the heart. The author considers cardiac form, size and motion, the aorta, the various heart lesions, the heart of cardiac hypertrophy and hypertension and myocarditis, congenital lesions and neurocirculatory asthenia.

In myocarditis, two types are considered: Those without cardiac dilatation, including the senile type and the arterial sclerotic type (angina pectoris); and those with cardiac dilatation, including the end stage of practically all valve lesions, the end stage of nutritional changes and the end stage of toxic changes.

In cases of the senile type, we see comparatively little enlargement. The position is transverse, usually considerably obscured by the dome of the diaphragm. There is an apparent lengthening of the arch with a prominent upper segment to the left. There is a low position of the auriculocaval junction. Occasionally we see associated senile emphysema and exaggerated bronchovascular shadows of the articulated type.

In myocardial degeneration with dilatation the area is increased and the outlines are variably altered. The shadow is obscured by a high diaphragm and, not infrequently, the increased density of adjoining lower lobes of the lungs. Often only enlargement can be determined. The cardiac movements are disorganized and lack in purpose and effectiveness.

In myocarditis due to hyperthyroidism there is moderate or no enlargement, the heart is shapeless, flaccid, the pulsations are futile, the impulse is not well sustained, there is tachycardia and generally a substernal goiter.

Carr, James G., and Hanford, C. W. Carcinoma of the Esophagus with Perforation of the Aorta: Observations on Radium Therapy. *Am. J. M. Sc.*, Sept., 1922, clxiv, 3, p. 340.

Since the publication of Knaut, in 1896, 21 cases of esophageal carcinoma with perforation of the aorta or other large vessels have been reported. Another case is added by the authors.

Autopsy findings in the case here reported disclosed certain deficiencies in the application of radium therapy. Suggestions are made for more effective technique.

Fluoroscopic control does not necessarily mean treatment of the entire tumor. Under fluoroscopic control accurate measurements must be made as to the location of the tumor and its length. It is not enough to insert the radium from above. Until the tumor, for its entire length, is permeable to a sufficient degree to admit the capsule, so that the capsule may be passed the entire length and redrawn into the area, to be located at different levels, we cannot feel that our technique is directed to the treatment of the accessible growth in its entirety.

Campbell, Don M., Carter, John M., and Doub, Howard P. Roentgen Ray Studies of the Nasolacrymal Passageways. *Arch. Ophth.*, Sept., 1922, li, 5, p. 462.

By *x*-ray studies the authors have been able to demonstrate on the living subject:

1. That the nasolacrymal duct and sac may have a side-to-side joining.
2. The passageways on one side may be very malformed and irregular in their course, while those draining the opposite eye may be regular in contour.
3. The passageways in the black race are, as a rule, much wider and more regular in outline than are found in the white race.
4. The lacrymal sac may, as the result of infection and obstruction, be extremely dilated, or again, it may be very small and contracted, and also, there may be fistulae leading from the sac.
5. By the method herein described it is possible easily to demonstrate the position which the lacrymal passageways occupy relative to the middle turbinate.

It would seem that we are justified in concluding that satisfactory *x*-ray data on the nasolacrymal passageways, showing the point of obstruction, the size of the sac, and its position relative to the intranasal structures is of practical value in that it allows us to make more accurate diagnoses, and to plan our relief with greater precision.

Quick, Douglas, and Johnson, Fred M. Cancer of the Larynx Treated by Radium. *N. York State J. M.*, Oct., 1922, xxii, 10, p. 462.

This report of experience at the Memorial Hospital, New York, must be regarded as incomplete experimental evidence. Nevertheless, results to date give definite proof of the value of radium in these cases. Technique has changed so radically in late years that, in comparable cases, the work of today cannot be compared with that of one, two, or five years ago, and the literature gives very few data of value.

A considerable percentage of intrinsic growths are inoperable when seen by the laryngeal surgeon. In applying radium to a laryngeal growth, certain difficulties arise which are not met with in other parts of the body. If efficiently applied, radium creates a sharp inflammatory reaction of several weeks' duration, and, in the cases under discussion, this reaction is just at the vantage point of two body systems. It often interferes with both swallowing and breathing. Hence the danger of impairment of the patient's general health, which is usually already undermined. It is impossible to put the treated part at rest, and consequently the factor of mechanical irritation is added. It is very frequently impossible accurately to determine the extent of the disease in these cases. Vision alone is not sufficient aid in satisfactorily examining a malignant growth. Palpation, to determine the depth of neoplastic infiltration, is most important; but, except for a few extrinsic lesions, this is impossible in laryngeal work.

The inflammatory reaction causes pain, and may interfere with swallowing and breathing as a result of edema. In bulky extrinsic growths, sloughing and hemorrhage must be reckoned with. A tracheotomy may be necessary before beginning treatment, or may become imperative. If only palliative relief can be hoped for, then the patient's physical comfort demands first consideration.

If a pack of sufficient amount of radium is not available for external application, then efficient *x*-radiation should be used as a second choice. The authors, however, prefer heavily filtered radium applied over both sides of the neck directly toward the primary growth. For external treatment, the greatest advance has been through the introduction of radium emanation tubes directly into the growth through fine trocar needles under local anesthesia. There is some danger from introducing mixed infection deeper into the tissues; but this is slight, especially if care be taken to avoid introducing through ulcerating surfaces. The glass emanation tubes have not given any trouble as foreign bodies, being either expelled or expectorated with minute particles of slough, later on, or buried in scar tissue. Tubes of small individual values should be used, approximating 1 mc. each. In selected cases of localized, relatively superficial growths a small glass bulb, 6 to 8 mm. in diameter and containing 500 or 600 mc. of emanation, is applied, mounted in a protecting metal cone with paraffin. A few minutes of this unfiltered irradiation is sufficient.

Surgery has been combined with irradiation wherever it seemed reasonable, particularly laryngofissure as a means of more accurately exposing deeply infiltrating growths.

A long series of valuable statistics is given. The authors conclude that, while the treatment of primary, operable, intrinsic cancer of the larnyx is permissible, we have no evidence thus far to justify advocating it as the agent of choice. The authors believe that the pre-operative use of radium in operable cases adds materially to the end-result. Radium should be withheld in the very advanced cases.

Glass. Development of X-ray Plates in Bright Light (Safranine Method). *Deutsche Med. Wchnschr.*, 1921, No. 34.

Previous attempts to develop roentgen plates in bright light were not successful, because, either the plates were fogged, or they could not be removed from the developer for observation. Lüppo-Cramer reported a new method of development in a pamphlet entitled "Development of Negatives in Bright Light (Safranine Method)." The author has tested this method and recommends very strongly its employment. The principle is that by immersion of the exposed plate in a solution a phenosafranine before developing, or by the addition of this solution to the developer itself, the plate, which has hitherto been sensitive to light, becomes desensitized so that bright yellow light or candle light cannot harm it any more. The following is the method of procedure: 10 cm. of a stock solution of phenosafranine 1:2,000 are added to each 100 cu. cm. of developing solution; the plate is immersed for one minute in this solution, and can then be developed under the yellow or candle light. The other method is to bathe the plate under red light for one minute in a phenosafranine solution of 0.05 per cent, and to develop the plate in bright light in the ordinary solution, the plate must then be thoroughly rinsed before developing. The author's tests have shown that a perfect negative, free from fog, can be obtained, if the plates are treated with phenosafranine before the exposure is made, or after the exposure but immediately before developing. With glycin, developing becomes somewhat slower, owing to the impregnation of the emulsion with safranine. As a source of light, he employs a 32 candle-power electric bulb filtered through a tartracin gelatin film. The advantage of this method, according to the author, rests in the fact that the negative can be judged at the beginning of the development.

Böttner. Roentgen Therapy of Polycythemia with Special Consideration of the Question of Cure. *Deutsche med. Wchnschr.*, 1921, No. 27.

In a previous communication, the author reported the cure of a patient with pronounced polycythemia (enlarged spleen, typical changes of the skin and of the mucous membranes, 145 per cent hemoglobin, 9,800,000 red cells). The successful result of the irradiation so far has lasted for one and a half years. In 2 further cases of polycythemia, the roentgen deep therapy of the bones and of the spleen did produce a return of the red cells to normal, but did not bring about a cure, as in the previous case. There is no cure, if, after a cessation of the increase in red cells, the normal erythrolysis does not suffice to cause their diminution. Roentgen irradiation then has no curative, but merely a symptomatic effect. It is possible that the blood-vessels which have acquired a compensatory dilatation have, in the course of years, lost the ability to return to normal and cause a compensatory increase in erythrocytes. At all events, the author believes that the optimism regarding roentgen therapy in polycythemia is not justified, inasmuch as in several cases the roentgen rays have only a symptomatic effect.

KOHLER. X-ray Treatment of Pathological Fractures. *Deutsche med. Wchnschr.*, 1921 No. 26.

In the case of an elderly woman who had a pathological fracture of the femur due to metastatic carcinoma from the breast, the fracture was treated with small doses of *x*-ray. The fracture healed, but the tumor continued to grow rapidly. This goes to show that small stimulating doses cause growth, not only of the osteoblasts, but also of the tumor cells. Thereupon, 2 similar cases were treated with large doses. Technique: Large distant fields, two portals of entry, 18 by 14 cm., 50 cm. focus-skin distance, one skin unit dose each, 0.5 mm. zinc filter and 3.0 mm. Al. filter. Inasmuch as the surface of the upper arm is too small for the large distance field irradiation, it was wrapped in moist cellulose in a manner similar to that which Jüngling has described for bolus alba. In both cases the result was sclerosis of the bone and healing of the tumor by ossification. Cachexia ceased; after several months the patients who formerly had been very cachectic, gained a perfectly healthy appearance. In one case there was metastatic carcinoma of the neck of the femur, in the other case metastatic sarcoma in the head of the humerus with numerous pulmonary metastases.

BASCH. Roentgen Irradiation of Inflamed Sweat Glands in the Axilla. *Deutsche med. Wchnschr.*, 1921, No. 31.

Sebaceous and sweat-glands are extremely radiosensitive organs of the skin which undergo degenerative changes after weak irradiations and atrophy after strong irradiations. In most cases, the effect of the irradiation is shown after a few hours in the remission of pain, followed soon by the retrogression of the infiltrations or of the abscesses. In large abscesses the puncture incision is sufficient to bring about a cure. The author employs in every stage of the disease hard radiation filtered through 4.0 mm. and administers 15X = 1½ S.N. If after ten days, infiltration rests are still present, the same dose of radiation is applied again. The author considers in these cases, roentgen treatment as the therapy of choice, since, in a simple manner it produces healing of the disease by attacking the cause. He obtains this result in a much shorter time than by other methods of treatment.

LEXER. Treatment of Surgical Tuberculosis. *Deutsche med. Wchnschr.*, 1921, No. 29.

Surgical treatment of localized tuberculosis must be thorough; the author warns against insufficient procedure. There are frequently presented for treatment, cases which have been protracted too long under conservative treatment or have been made worse by insufficient surgical procedure. Synovial articular tuberculosis should be operated upon, if the tuberculous granulations become purulent, if pathological articulations occur, or when fistulae may cause putrid or general infection. In cases of articular tuberculosis affecting the bones, conservative treatment should be attempted only in children. Lexer operates upon every case of bone tuberculosis, if sequestra which are easily within reach, continue to cause abscess formation. In more deeply situated foci he employs the old method of treating the abscess by puncture and injection of iodoform-glycerin. In cases of tuberculous spondylitis, he incises abscesses only when they arise from a vertebral arch whose diseased portions can be removed, or when compression myelitis does not recede under traction. The author does not employ Albee's operation. Large tuberculous lymph-nodes, which are not adherent to the surrounding tissues, are cured by operation and postoperative radiation. As the principal means of conservative treatment, the author mentions sun baths at high altitudes and roentgen therapy; but even in the lowlands, sun treatment can produce good results and should in the winter be replaced by "artificial altitude sun." Roentgen irradiations cause tuberculous granulations to shrink and to form scars, and stimulate periosteal new bone formation in bony tuberculous foci. In cases of tuberculosis of the vertebrae, the roentgen rays will, in a few months, produce complete rigidity. The pressure pain disappears immediately. On the average, six months are required to produce complete rigidity of the spine. In cases of articular tuberculosis, especially in children, not only cure, but also mobility of the joints is produced. In cases of bone tuberculosis, the short tubular bones react particularly well. In such cases, Lexer had remarkable results in children. In adults, irradiation of larger foci in the spongiosa and in the bone marrow was completely ineffectual. The determination of the correct dosage of roentgen rays is not easy, even for experienced roentgenologists. With too large doses, scar formation does not occur, but there is a purulent breaking down of the granulation tissue. Tuberculous lymph-nodes should be treated experimentally by stimulating doses, so as to cause their disappearance. If the enlarged nodes adhere to one another by periadenitis, diminution by scar formation cannot be expected, because we are dealing here with encapsulated large caseous masses. By larger doses such nodes can quickly be made to form abscesses. Abscesses should be evacuated by puncture before irradiation. Iodoform-glycerin should not be injected as long as the patient is under treatment. (Haenisch of Hamburg saw in 2 cases of abscess of the nodes which were on the point of rupture, extensive ulcerations, which, however, gave no sign of roentgen ulcer, and which healed with the formation of granulation tissue. He emphatically warns against irradiation in cases in which the skin over the abscess has already become thinned out by the inflammatory process. After rupture has occurred, small dose radiation is indicated. Note of the Reviewer.)

LASCH. The Effect of Artificial High Altitude Sun on Metabolism (Alpine Lamp). *Deutsche med. Wchnschr.*, 1921, No. 36.

As a result of his experiments in metabolism, the author found that the rays of artificial high-altitude sun produced in rachitic children a very markedly increased retention of calcium and phosphorus, and that this increase continued for some time after the process of healing had terminated clinically. Particularly remarkable was the rapidity of onset of this effect of the artificial high-altitude sun. He concludes that in rachitis the process is one of disturbance of the intermediary metabolism. A similar effect, with equal rapidity of onset, was observed by Schabad, some time ago, in his experiments on metabolism with cod liver oil.

RAUSCHBURG. Two Cases of Hypophyseal Dystrophia Adiposogenitalis and Their Treatment by Means of the Roentgen Rays. *Deutsche med. Wchnschr.*, 1921, No. 43.

Two patients with adipose dystrophy and with tumors of the sella turcica were treated with roentgen rays because of the presence of very severe manifestations of brain symptoms. After several months, there was marked improvement, which lasted during the nine months of observation. In the first case, which was that of a nineteen year-old student, there were, in addition to the symptoms of adipose dystrophy, severe changes in the region of the sella, diminution of vision as the result of increasing papillitis, attacks of vertigo and intolerable headaches. Four months after irradiation the manifestations referable to the tumor had disappeared, and after nine months the condition of the patients was very satisfactory; the choked disc had been cured, leaving no defect; the childish mental state had disappeared; the mental facilities had been considerably improved. In the second case, that of a fifty year-old woman, there was total blindness, enlargement of the sella, nausea, insomnia, mental depression and loss of interest. Ten days after the first irradiation, vision improved, and the power of vision rose gradually to 5/10. After a few months, the patient felt absolutely well physically as well as mentally. There were three irradiations. The examination nine months after the treatment showed that the condition was still as favorable, without the slightest change for the worse. In both cases, the repeated intensive irradiations had destroyed the tumor tissue, but at the same time had no injurious effect upon the psychological and other functions of the brain.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X FEBRUARY, 1923 No. 2

STUDIES OF THE MECHANISM OF MOVEMENT OF THE MUCOUS MEMBRANE OF THE DIGESTIVE TRACT*

BY GÖSTA FORSSELL, M.D.

STOCKHOLM, SWEDEN

THE folds of the mucous membrane of the stomach are generally supposed to be caused by a passive folding-in, as a consequence of the contraction of the muscular coat (muscularis propria). The origin of some of the folds of the mucous membrane of the intestines is explained in this manner; other folds are supposed to be permanent anatomical structures.

I have proved that this prevailing opinion is not correct, the folds of the mucous membrane of the alimentary canal being formed by active movements of the mucous membrane itself.

By pictures of anatomical preparations, series of roentgenograms and photographs of the digestive tract of living beings, I shall attempt to show how I arrived at this opinion, which differs from the prevailing view.

Figure 1 shows the surface of the mucous membrane of a normal stomach. The stomach is cut in the curvatura major and opened, showing a surface of the same width on both sides of the curvatura minor. The mucous membrane of the posterior and anterior walls of the stomach shows, notwithstanding, a relief of a totally different type.

To the left of the curvatura minor there are high folds with close transverse folds, while to the right there are only a small number of low folds. The surface of the mucous membrane between these low folds shows a fine mammillated surface, the so-called *état mamelonné.* By comparing the areas of the anterior surface with the corresponding areas of the posterior surface, the difference will be found striking.

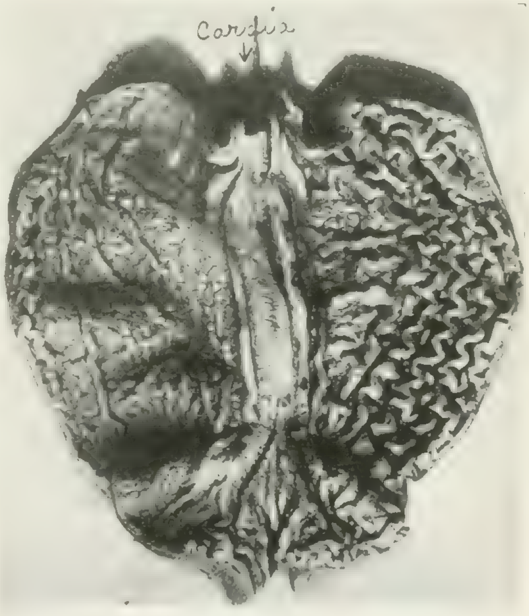


FIG. 1. The mucous membrane of a normal stomach.

In Figure 2, you will be able to ascertain how the relief of the mucous membrane in one and the same stomach is not only essentially unlike in the areas with about

---

* Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

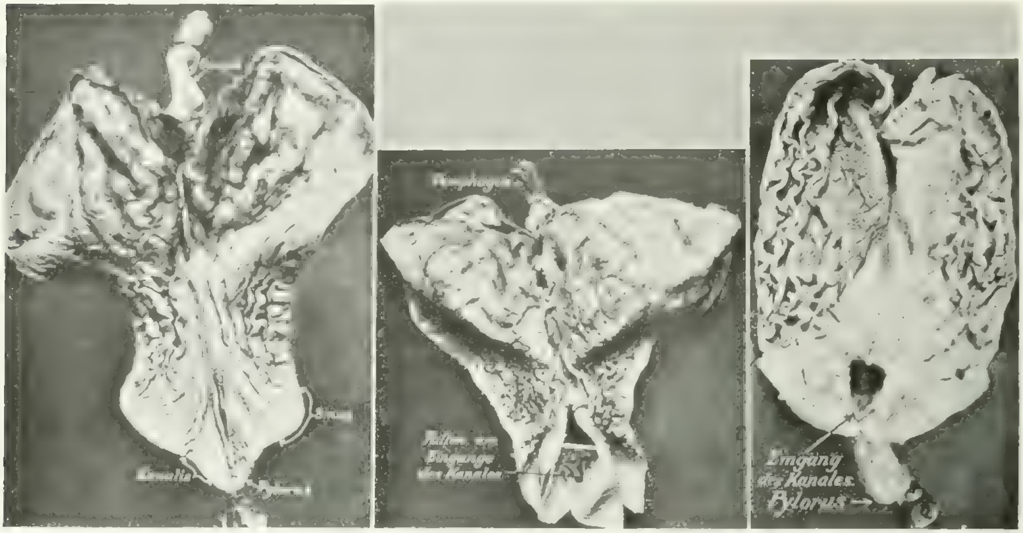


Fig. 2. Photos of the mucous membranes of three human stomachs reproduced in the author's work, Über die Beziehung der Rontgenbilder des menschlichen Magens zu seinem anatomischen Bau. Hamburg, 1913.

↑(3)

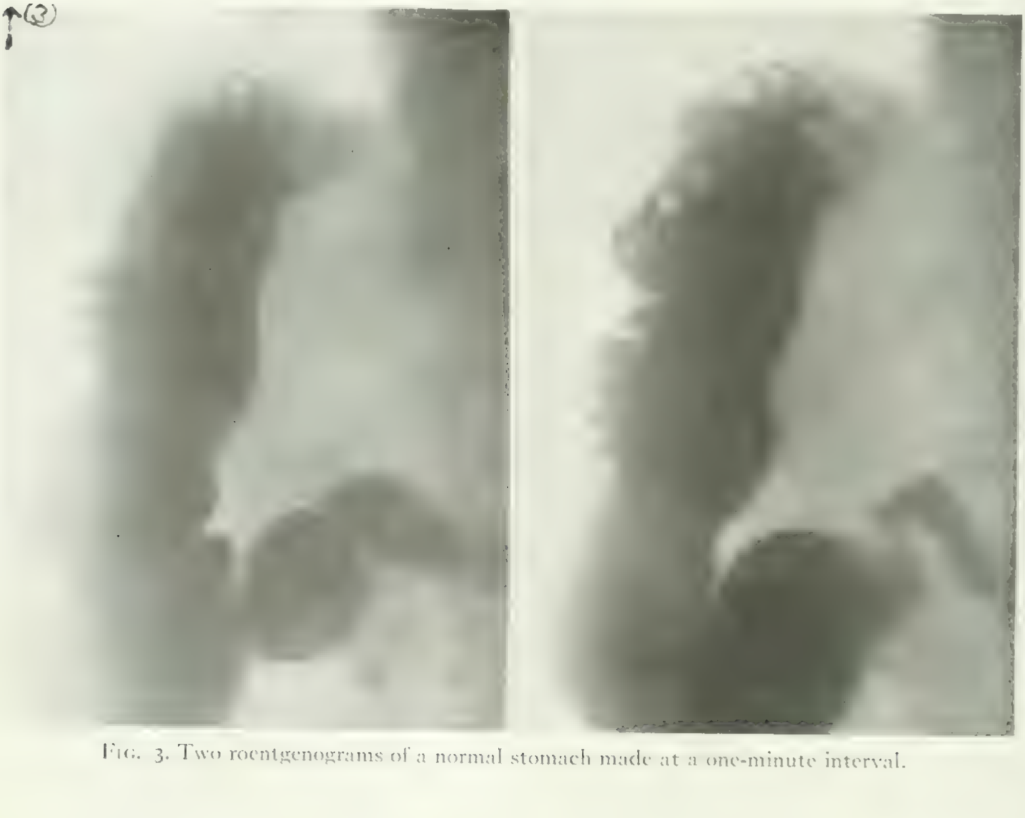


Fig. 3. Two roentgenograms of a normal stomach made at a one-minute interval.

the same width of muscular coat, but that different stomachs show very different reliefs of the mucous membrane in corresponding areas with about the same contraction of the muscular coat.

is then contracted through the building of a kind of mammillated surface. Thus arises the so-called *état mamelonné* (mammillated state) which is a form of contraction of the mucous membrane.

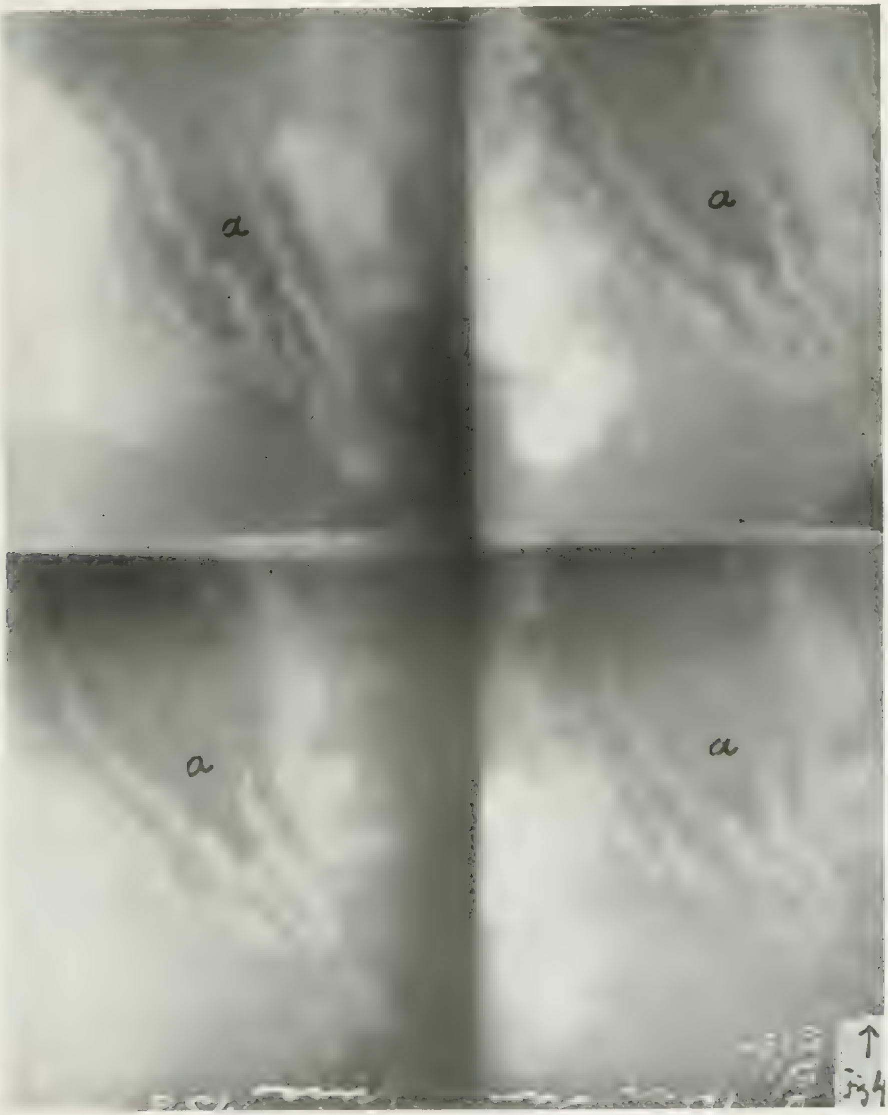


FIG. 4. A series of four roentgenograms of a limited area of the corpus ventriculi showing the mucous membrane, made at one-half minute intervals.

In all these stomachs, shown in Figure 2, it can be observed that the mucous membrane, even in very strongly contracted areas (for instance, in the area of the sinus in Figure 1) can maintain a foldless surface. The mucous membrane

Many pictures of the same kind caused me to doubt the correctness of the old explanation of the origin of the folds of the mucous membrane. It seemed to me unlikely that a purely passive folding-in of the mucous membrane could produce so different a folding of the mucous membrane with an apparently similar contraction of the underlying muscular coat. The thought arose then, that possibly the relief of the mucous membrane was formed independently of the contraction of the muscular coat through independent and appropriate movements of the mucous membrane itself; that therefore, the relief of the mucous membrane, as it was shown on the anatomical preparations, and in the roentgenograms, represented a phase of a state of movement.

Hence, my attention was directed towards the attempt to observe movements of the contours of the mucous membrane; and, in 1912, I succeeded with the help of radioscopy to observe movements of the mucous membrane in the upper part of the stomach. Later on I succeeded, with the help of improved technique, in demonstrating in a series of roentgenograms a visible movement of the folds of the mucous membrane.

Figure 3 shows two roentgenograms of a normal stomach, at an interval of one minute, in an unchanged prone position. If one compares the contours of curvatura major in its upper half, where the mucous membrane shows deep folds, one will observe how the folds of the mucous membrane changed their number as well as their position and form, without the stomach at this point having visibly changed its width.

Figure 4 shows a series of four roentgenograms of a stomach made in the supine position, at intervals of half a minute. A careful study will show that the folds of the mucous membrane have changed form and width in this short time. Attention should be directed to the changing forms and width of the groove between the two folds marked with *a*.

Figure 5 shows the change of the folds of the mucous membrane within the pyloric canal (area *a*) on two roentgenograms made in the standing position at an interval of about three-quarters of a minute. The width of the pyloric canal is about the same and the circular contraction of the muscular coat is situated in about the same area on the edge of the pyloric canal. But the number, form and position of the folds of the mucous membrane are apparently different in both roentgenograms. (*P*, pylorus.)

In a state of greater expansion of the muscular coat no folds appear on the mucous membrane. A certain degree of contraction of the muscular coat with corresponding diminution of the cavity of the stomach seems, therefore, to be necessary for a formation of the folds on the surface of the mucous membrane.

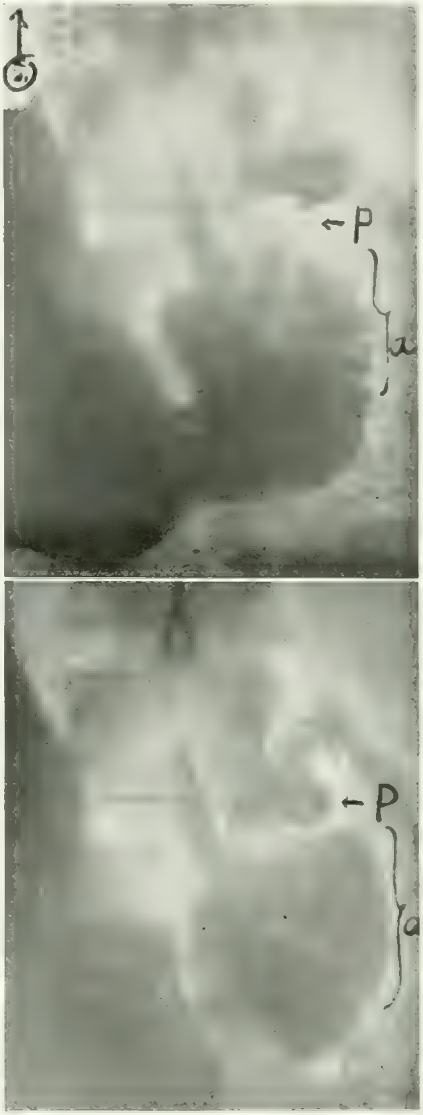


Fig. 5. Two roentgenograms showing the mucous folds of a pyloric canal, made at an interval of about forty-five seconds.

However, folds on the mucous membrane appear synchronously with a moderate contraction of the muscular coat of the stomach. Especially during the later period of digestion, and, above all, when in a recumbent position, the lower part of the stomach contracts to form a channel, a rich relief of the mucous membrane appearing.

Figure 6 shows a series of cross-cut pictures of the lumen of the stomach, drawn after anatomical preparations. It can be seen how the lumen of the stomach with the same width of the muscular coat, can vary considerably through different foldings of the mucous membrane, with regard to the form, as well as to the width, of the inner surface of the stomach.

Through such forms of contraction of the mucous membrane, which are shown in Figure 6—and many other combinations are further possible—the lumen of the stomach may be formed either as a channel with smooth sides or be divided into different canals or systems of fissures between the lamellæ. These may be placed in different ways, so that a filtering or sorting of the contents can take place; or the small parts of the contents may be covered with a mucous membrane in small digestion chambers, in order to be emptied into the cavity in an appropriate state of digestion.

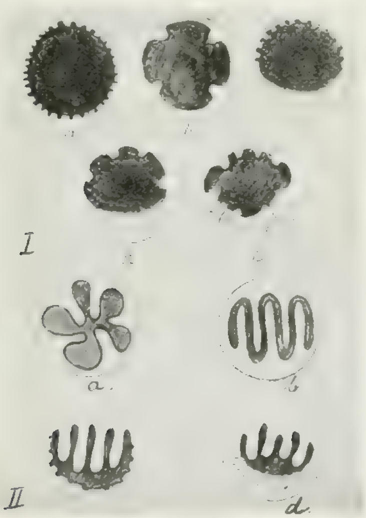


Fig. 6. A series of cross-cuts of the lumen of the stomach drawn after anatomical preparations.

Similar to what has just been stated in regard to the folds of the mucous membrane of the stomach, obtains in regard to the folds of the mucous membrane of the intestines. From the earliest times, the point of view has prevailed that the folds of the mucous membrane are passive structures, and the supposition was that they either originated through a folding-in of the mucous membrane by the contraction of the muscular coat, or that they were permanent anatomical structures (*Dauerfalten*). Even the roentgenological literature is dominated by the same theory. A finer division of the contents of the intestines, or an increased width of the folds, is supposed to depend on hypertrophy.

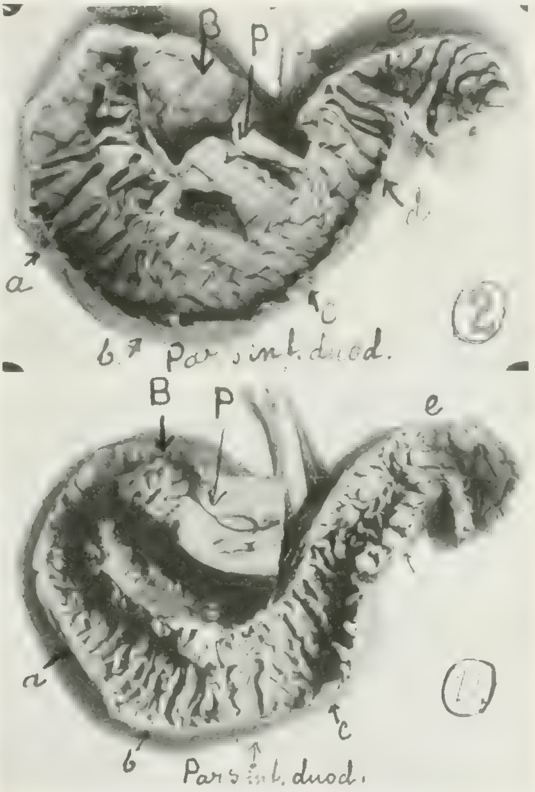


Fig. 7. Two normal anatomical preparations of the mucous membrane of the duodenum. P = pylorus. B = duodenal bulb.

The bulbus duodeni is described as free from folds of the mucous membrane, and different anatomical forms are attributed to the valvulae conniventes of the duodenum and the small intestines. All thought of a change of form of the folds of the mucous membrane, on account of a movement of their own, has been completely ignored. But a closer study of the structure of the relief of the folds of the mucous membrane of the intestines on anatomical preparations and on the living intestines will give rise to another view.

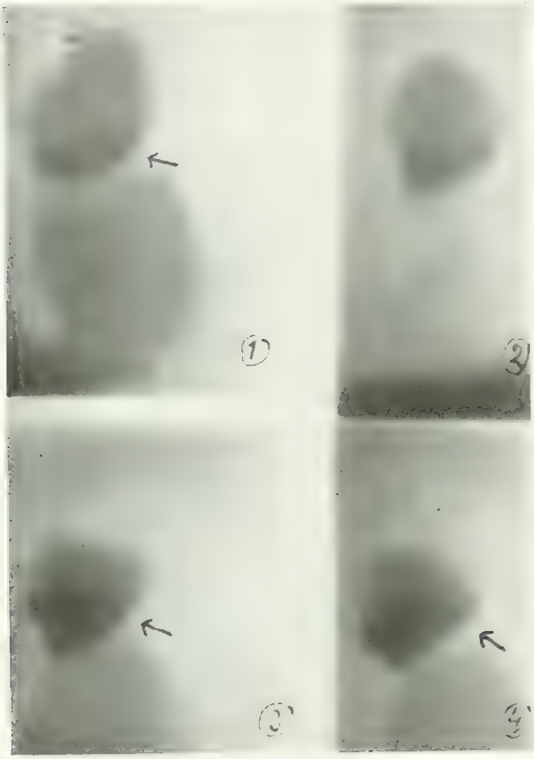


Fig. 8. A series of four roentgenograms of a normal duodenal bulb.

Figure 7 shows two anatomical preparations (2, 11) of the duodenum from patients with normal intestinal canals, who died of pneumonia. The preparations represent the posterior half of the entire duodenum. The stomach is cut away through the canalis pylori. (*P*, pylorus; *B*, bulbus duodeni.)

The upper preparation on the picture shows a bulb with smooth mucous membrane, as it is generally described. In the lower picture the mucous membrane in the bulbus is deeply folded with cerebral gyrus-like folds. If comparisons are made between the different areas of the same duodenum, for instance, between the areas *a* and *d* of the lower preparation, it will be noted that in spite of the duodenum having the same outer width, area *a* has low, simple folds, few in number, and a wide lumen, whereas area *d* has high, complicated, closely-placed folds and a narrow lumen.

These phenomena are not unique, but appear everywhere in well-conserved, anatomical preparations of the duodenum. The bulbus duodeni, which until now was supposed to be free from folds, has a very changeable relief of the mucous membrane, similar to the entire duodenum.

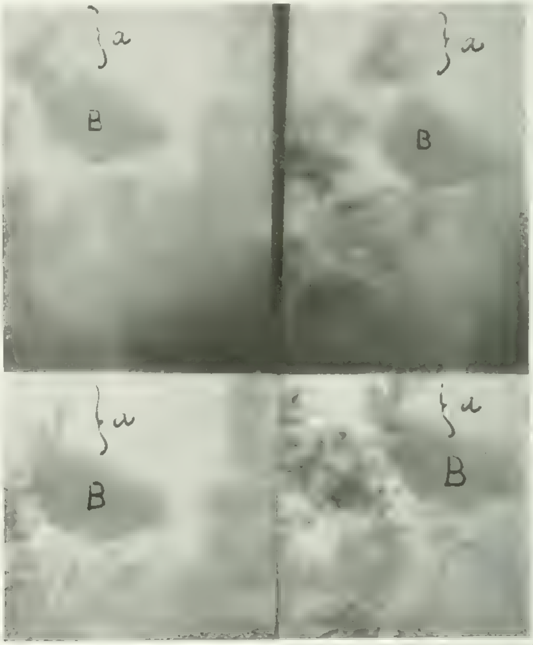


Fig. 9. A series of four roentgenograms of a normal duodenal bulb and the superior part of the duodenum, made at two-minute intervals.

The depth and form of the relief of the mucous membrane are not directly dependent on the width of the intestines (degree of contraction) since the most dissimilar reliefs of the mucous membrane may occur at a certain width of the intestinal canal.

An important question presents itself now: Are these folds characteristic of individuals and eventually for locality, or do they change here, as in the stomach, in the same place?

The following illustrations will solve this question: Figure 8 shows a series of four roentgenograms of a bulbus duodeni, which, in the first, shows a quite smooth surface of the mucous membrane. In No. 3, small, typical folds of the mucous membrane appear on the basal surface of the bulbus (*a*), and in No. 4, these small folds have changed position, number and depth. A folding of the basal surface of the bulbus has taken place and the fold has shown an apparent movement.

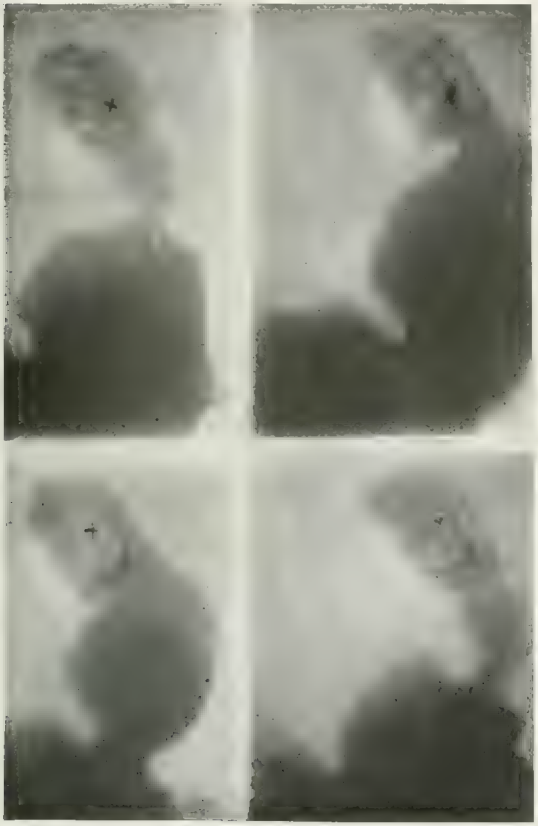


Fig. 10. Four roentgenograms showing a normal duodenal bulb.

Figure 9 shows a series of four roentgenograms, made at intervals of two minutes, of a bulbus duodeni (*B*) and a pars superior duodeni (*a*); and it will be observed how, in all of them, the contours of the mucous membrane have apparently changed, altering position, form, direction and height of the folds. Figure 10 is a new series of four roentgenograms in which the folds of the mucous membrane in the bulbus appear distinctly, on account of the bulbus being partly filled with air, partly with a contrast meal.

By comparing the areas marked with a cross, it is easy to observe the movement of the folds of the mucous membrane, which changed the position and form during the intervals between the different exposures. (The same bulbus showed in other roentgenograms a smooth contour.)

Figure 11 is a series of roentgenograms from a patient with cancer of the stomach deforming the duodenal bulb. The pars inferior duodeni is here filled out, and one can see very well in the area marked *a* the change of the number, position, form and depth of the folds of the mucous membrane during the time of the making of the series of exposures.

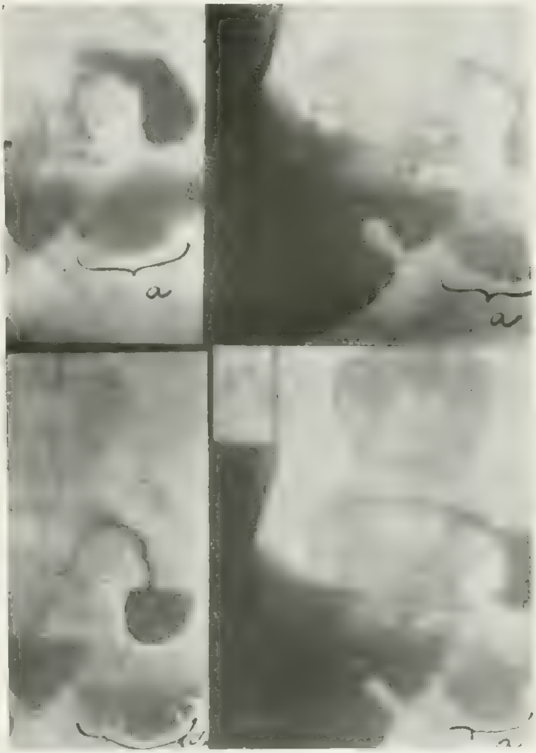


Fig. 11. A series of four roentgenograms of the folds of the mucous membrane of the inferior part of a duodenum made at intervals of about forty-five seconds.

An objection might be made to the effect that the fold-like elevations in the lumen, which appear in the roentgenograms and which change form and place, were not caused by the folds of the mucous membrane, but by the contraction of the muscular coat, which could possibly produce the elevations in question in the lumen through small, local contraction.

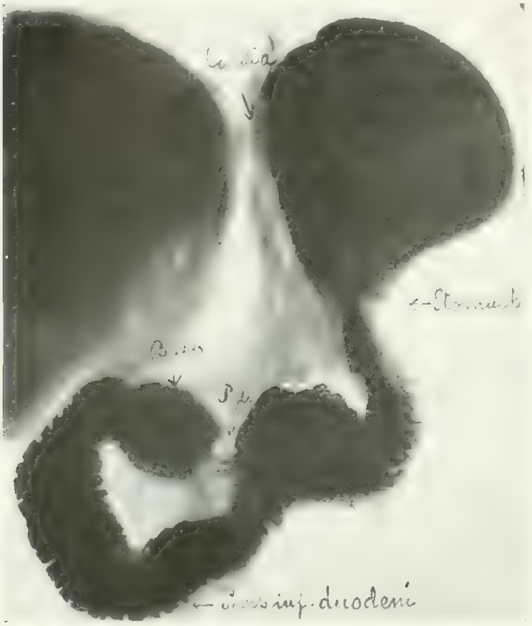


Fig. 12. A roentgenogram of the same anatomical preparation as in Figure 7.

A glance at Figure 12 will persuade you that the folded contours in the roentgenograms of the living duodenum correspond with the folds of the mucous membrane of the anatomical preparation. Figure 12 shows the same anatomical preparation of the duodenum shown in Figure 7 (No. 2), but here the lumen is filled with a contrast meal.

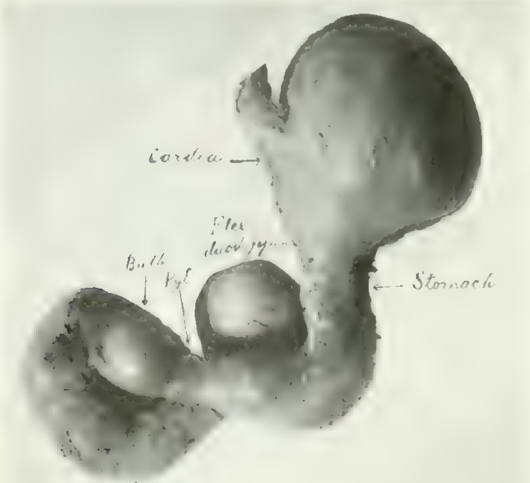


Fig. 13. The outer surface of the anatomical preparation of a duodenum which is shown in Figures 7 and 12.

One might be persuaded that the contours in this roentgenogram of the dead mucous membrane correspond entirely with the outlines which in the roentgenogram of the living duodenum have been interpreted as folds of the mucous membrane.

Figure 13 illustrates the outer surface of the same preparation, and shows the muscular coat smooth, and without any local constrictions that are capable of causing the fine elevations in the lumen, interpreted as folds of the mucous membrane.

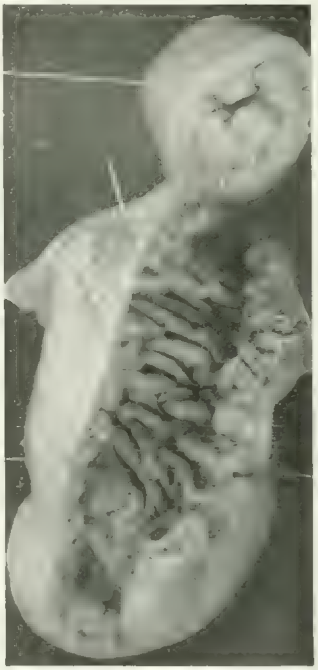


Fig. 14. Anatomical preparation of the mucous membrane from a proximal loop of the jejunum.

Figure 14 shows an anatomical preparation of the surface of the mucous membrane from a proximal loop of the jejunum. The folds are high and close together with rich, transversal folds, surrounding numerous small, digestive chambers that lead to a central lumen. This is the usual description of the jejunum.

Figure 15 demonstrates a roentgenogram of a living intestine and shows a relief of the mucous membrane, corresponding to the previous illustration. The upper part of the jejunum (*A*) is divided into numerous digestive chambers, varying from the size of a hemp-seed to that of a grain of rice.

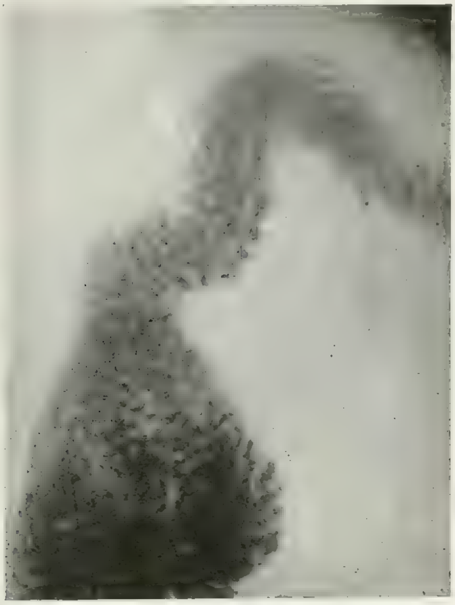


Fig. 15. Roentgenogram of a proximal loop of a jejunum in a live subject, corresponding to Figure 14.

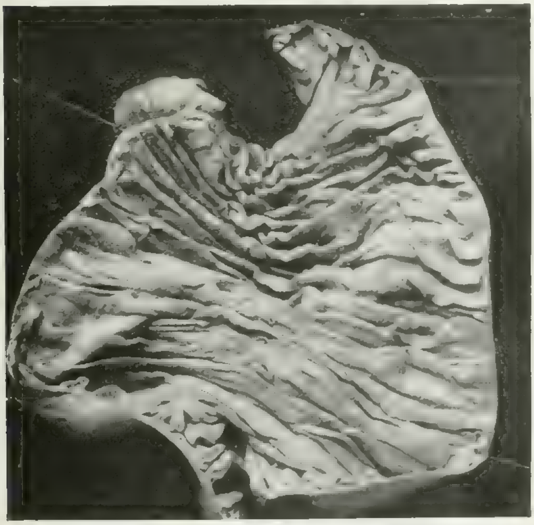


Fig. 16. Anatomical preparation of the mucous membrane on a loop of the jejunum immediately beside the loop shown in Figure 14.

Figure 16 shows the mucous membrane in a loop of the jejunum immediately beside the former. The folds are of a different type—simple, circular, and placed at longer intervals. The folds form more or less disc-like chambers which are broadly connected through a central lumen. Figure 17 shows a corresponding roentgenogram of a patient, in whom the upper part of the jejunum (*A*) has been speedily filled up by a gastroenteroanastomosis. To be recognized are the same simple, circular folds, forming digestive chambers in the form of discs. (*V*, stomach.)

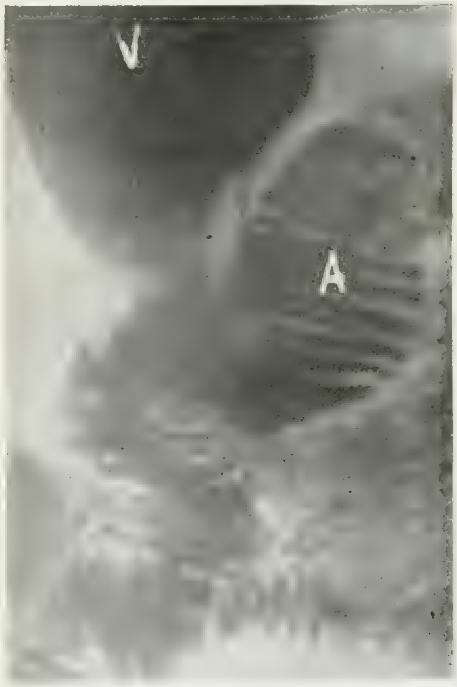


Fig. 17. Roentgenogram of a proximal loop of the jejunum, corresponding to Figure 16.

Figure 18 shows other types of the relief of the mucous membrane in the jejunum.

Special attention should be paid to the illustration marked with an arrow. The folds lap over each other similar to the lamellae of a cream separator; in this case they are directed towards the flow of the contents.

Figure 19 shows a roentgenogram of a corresponding formation in a living patient.

Some may think that the folds of the mucous membrane, in the various loops, could have a different structure. Serial roentgenograms of living beings show, however, that the same loop of small intestines can, in a short time, entirely change the relief of its mucous membrane.

Figure 20 shows two roentgenograms of a high jejunal loop, made at an interval of one minute. The area marked *a* should be specially noted.

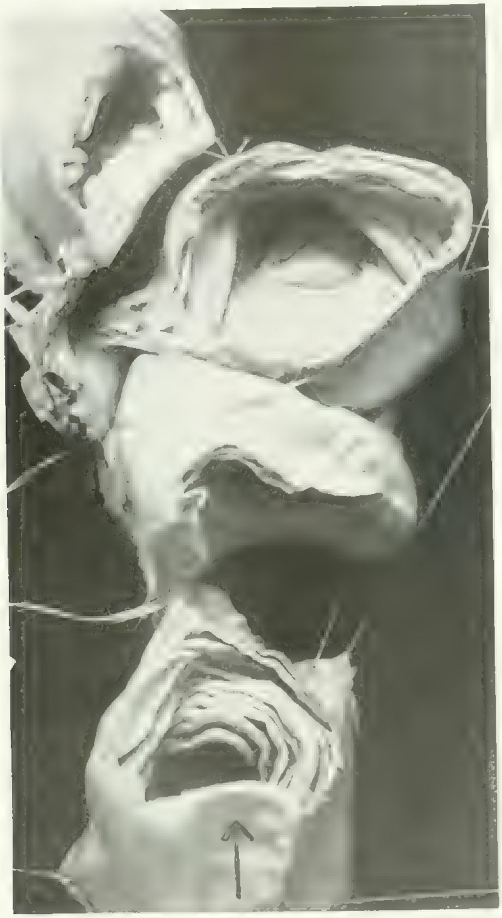


Fig. 18. A cross-cut of an anatomical preparation of a jejunal loop.

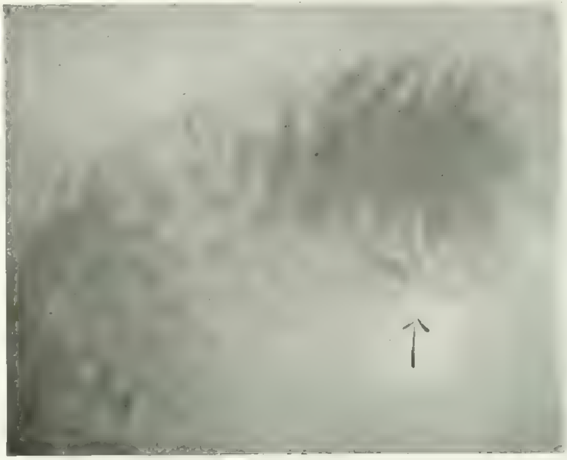


Fig. 19. Roentgenogram of a jejunal loop in a living subject, corresponding to the lower figure in Figure 18.

In the upper illustration, there are in this area a few wide, simple and deep folds. In the lower one, the relief in the same area of the mucous membrane has entirely changed. There are now numerous close-sitting, small folds, divided into transverse folds, which divide the lumen into fine, small chambers.

Figure 21 has two illustrations of ileal loops, made at an interval of ten minutes. Special attention should be paid to the loops in both, at point *b-c*.

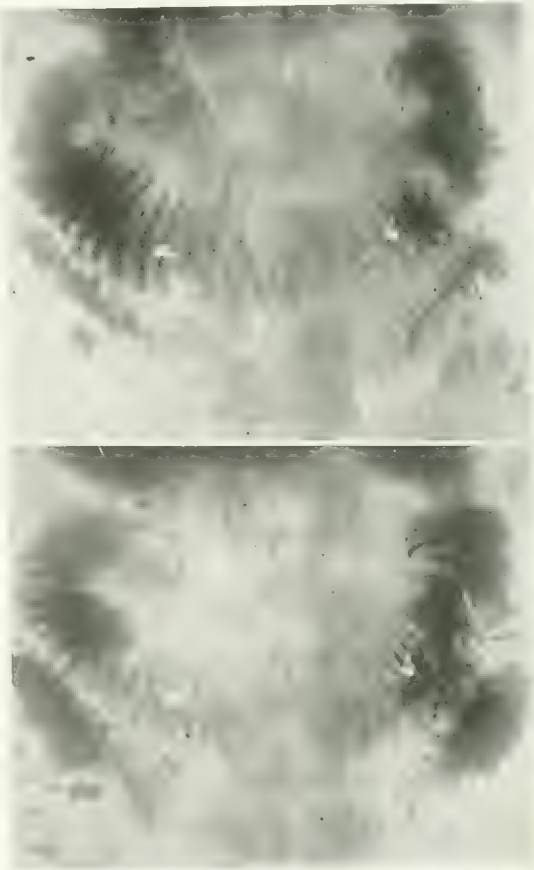


Fig. 20. Two roentgenograms of a jejunal loop in a living subject made at a one-minute interval.

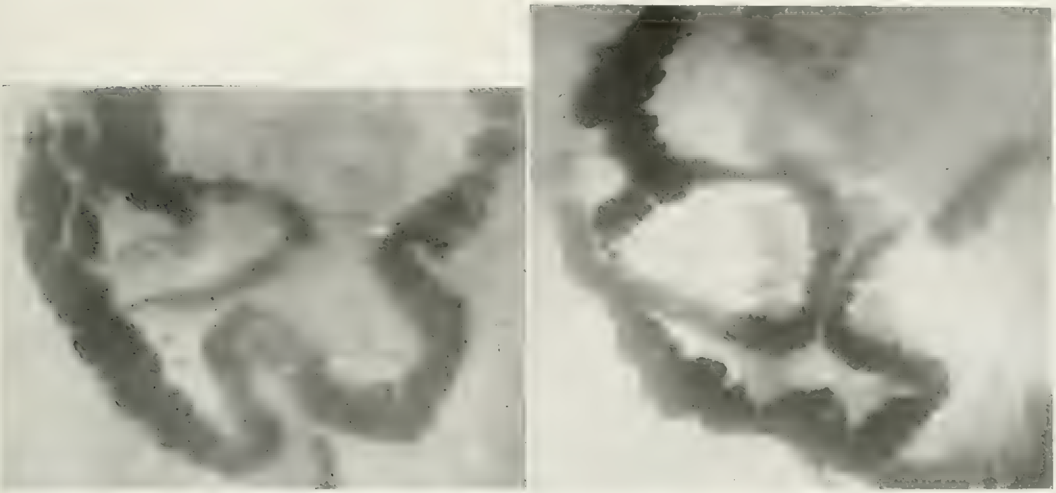


FIG. 21. Two roentgenograms of an ileal loop made at a ten-minute interval.

In the right one, this loop is divided into fine digestive chambers by close-sitting, fine, complicated folds.

In the left one, the surface of the mucous membrane of the same loop is nearly without folds. At the same time, in this illustration, a "segmentation" of this loop, according to Cannon, can be seen.

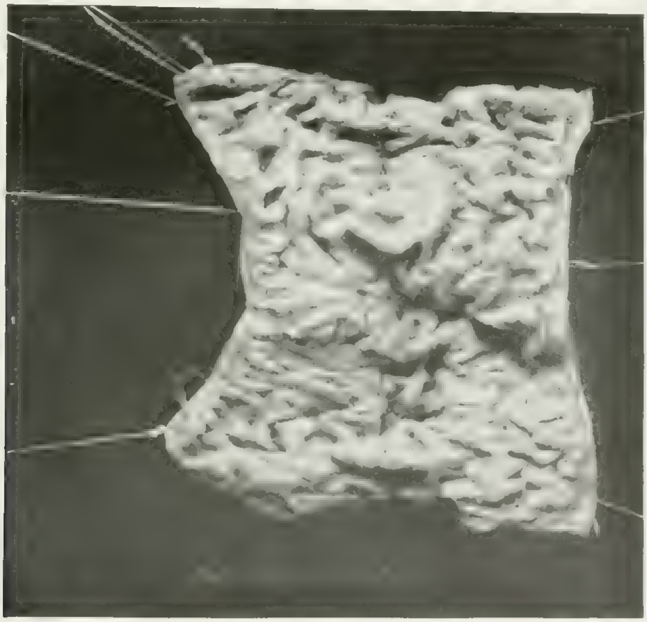


FIG. 22. Anatomical preparation of the mucous membrane of a low ileal loop.

According to prevalent descriptions, it is said that the folds of the ileum are lower than the folds of the jejunum and will slowly, totally disappear in the lowest part of the ileum.

It is true that generally the ileum shows lower folds than the jejunum; but the ileum can, in every part, show a relief of the mucous membrane quite as high and quite as complicated as the jejunum.

Figure 22 shows a surface of mucous membrane from the lower part of the ileum, which shows a very high and complicated relief of the mucous membrane, dividing the lumen into the finest digestive chambers.

Figure 23 shows a roentgenogram in which the terminal loops of ileum have been filled by a contrast clyster. In spite of their being relatively strongly dilated, these ileal loops (*A* and *B* in the illustration) show deep and close transverse folds, similar to the folds of the jejunal loop, which has been speedily filled by gastroenteroanastomosis. (*C*, cecum; *Fs*, flexura sigmoidea; *R*, rectum.)

Figure 24 is a roentgenogram in which the terminal loop of the ileum, four hours after a contrast meal, shows fine longitudinal folds, while the other loops of the ileum have the ordinary smooth outlines of the mucous membrane. (*C*, cecum.)

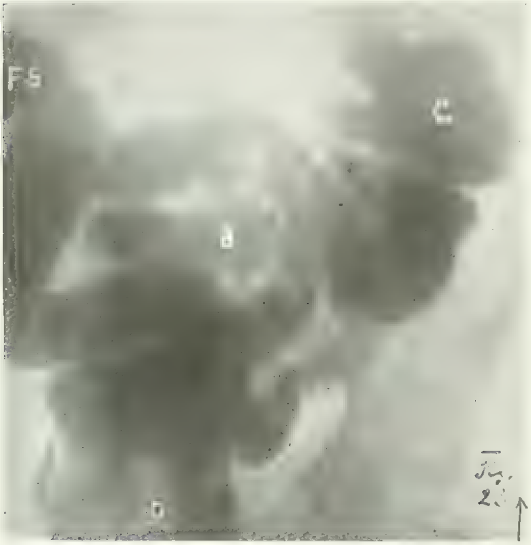


Fig. 23. Roentgenogram of the terminal loops of ileum A and B filled by a contrast clyster. C = Cecum; Fs = Flexura sigmoidea; R = rectum.

Figure 25 shows a number of loops of small intestines, filled up four hours after a contrast meal. In this illustration there are loops of the same width, which show different forms of relief of the mucous membrane.

For instance, if comparison is made between loops *a* and *b* which have nearly the same width, *a* is nearly without folds, *b* shows a deep and finely folded outline. The conditions are the same with *g* and *f*. The loop *e* shows on one side a close folding of the mucous membrane, but on the other side is free from folds, and shows on this side segment-contractions of the muscular coat.

According to my opinion, such a formation of the folds is inexplainable by only a passive folding-in of the mucous membrane depending only on the degree of contraction of the muscular coat. An independent movement of the mucous membrane seems to me to be the only possible explanation.

Through good fortune, I have been in a position to add the final link to the chain of evidence, through direct observations on a living mucous membrane. A fifteen-year-old boy, who had an ileal fistula, came to me for roentgen examination. He had an exposed mucous membrane about 3.5 × 4 cm. in size. Immediately after having taken away the compress, I saw the folds of the mucous membrane change form and position, without the exposed surface of the intestine having visibly changed size or form, and independent of the rhythmical contractions of the muscular coat that passed over the muscular coat about eight in a minute.

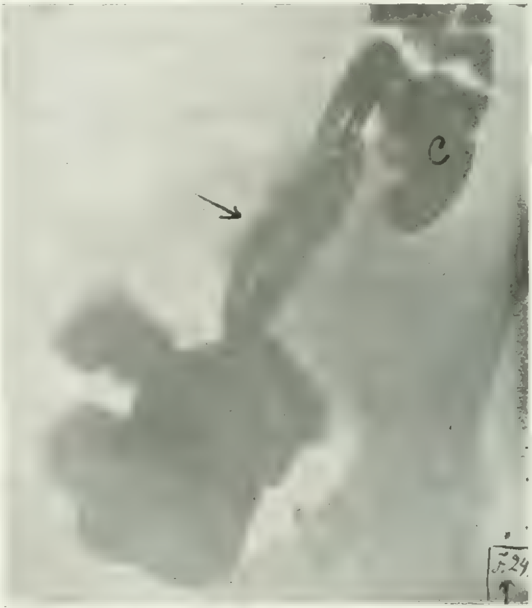


Fig. 24. Roentgenogram of the terminal loop of the ileum four hours after a contrast meal. C = Cecum.

I was in a position to take twelve photographs of the surface of the mucous membrane, in one hour's time. Figure 26 shows six of these pictures. A comparison between these different phases of movement will, better than words, illustrate the changing of the relief of the mucous membrane.

Comparison should be made between the areas marked with a cross on the different pictures. For instance, in phase 1, this mucous membrane area is nearly without folds; in the phases 2, 5, 9 and 10, it shows mostly transverse folds, changing in form and position, and in phase 12, fine vertical folds.

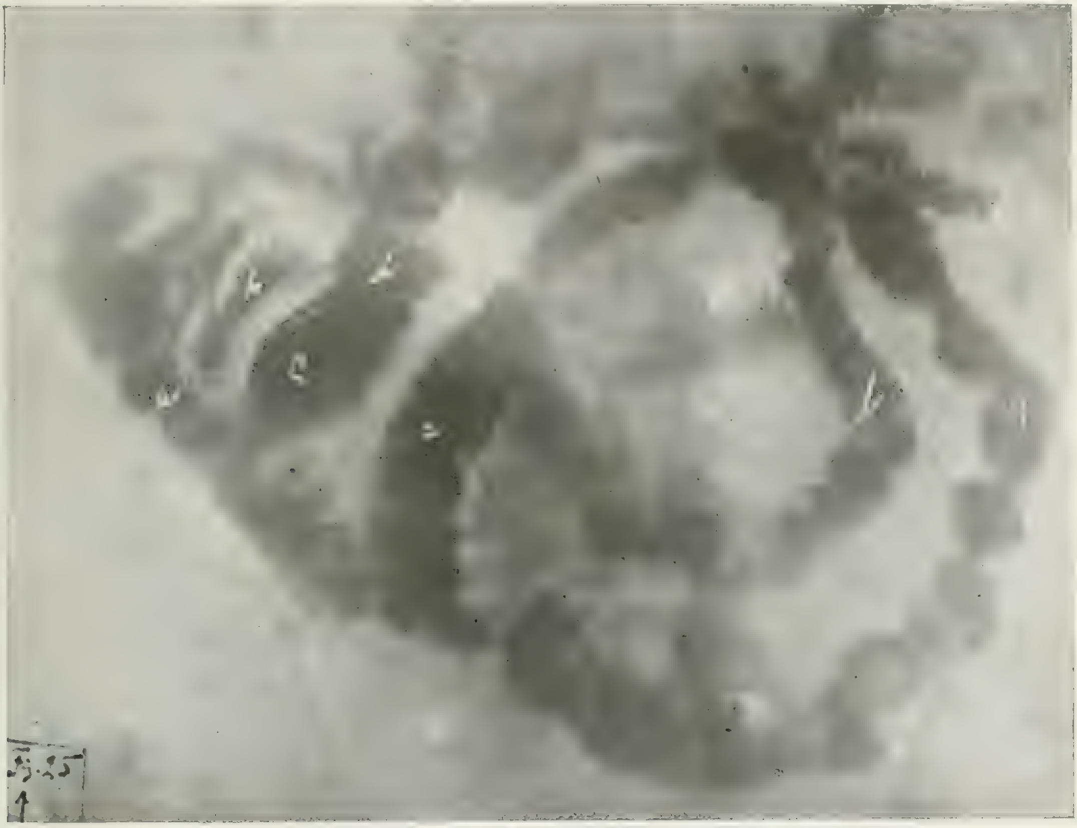


FIG. 25. Loops of small intestines filled up four hours after a contrast meal.

In the colon the genuine folds of the mucous membrane have aroused little interest, as the plicae semilunares, originated by the contractions of the muscular coat, have attracted all the attention. A study of the mucous membrane in anatomical preparations hardened shortly after death, as well as a close study of the roentgenograms, show, however, that the genuine folds of the mucous membrane play a very important part in the formation of the colonic lumen.

Figure 27 shows a part of the outer surface of a piece of flexura lienalis and the corresponding surface of the mucous membrane from the same preparation. A comparison between the two pictures will show you that the folds of the mucous membrane join to form ridges which bend into the lumen and play an important part in the modeling of the inner surface of a contracted colon.

Figure 28 also gives a clear idea of the great importance of the folds of the mucous membrane in forming septa in the colon.

In this picture, it is possible to look into the cavity of the flexura hepatica, and get an idea of the deep, circular diaphragm which is here formed by the high folds of the mucous membrane.

Figure 29 shows three transversal sections of a strongly contracted flexura sigmoidea. In the upper picture a muscular septum, originated from a transverse contraction of the muscular coat, fills up the lower half of the lumen. But, on the other hand, the folds of the mucous membrane fill up the cavity in such a way that it is possible to misconstrue them as a transverse section of the jejunum.

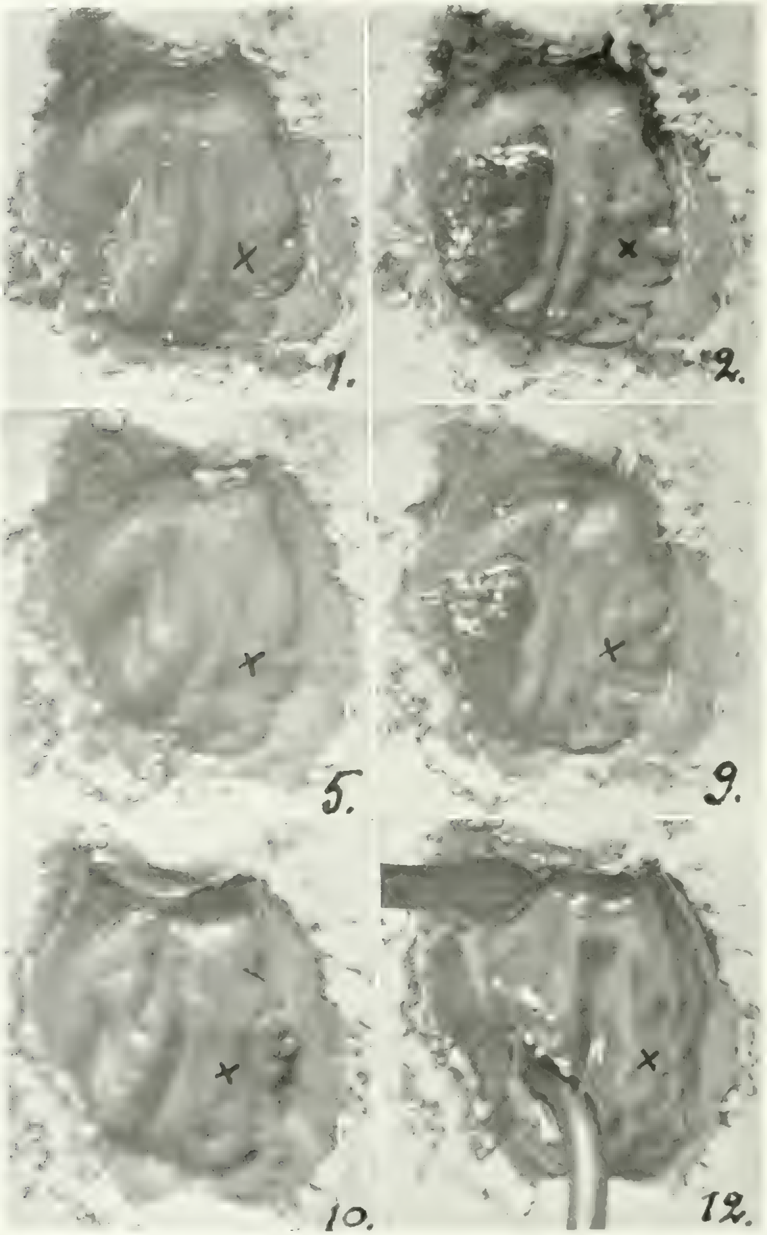


FIG. 26. A series of six illustrations of the living mucous membrane, exposed in an ileal fistula.

Examining an ordinary roentgenogram of the colon, as in Figure 30, we must, with our knowledge of the exterior form of the colon and of the relief of the mucous membrane, take for granted that the outlines of the roentgenogram, to a great degree, are defined by the relief of the mucous membrane. For instance, the high formed elevations (*K*) in the lumen are caused by the ridges of the mucous membrane bending into the cavity, and the smooth, rounded form of plicae semilunares

(*S*) is, without doubt, caused from the folds of the mucous membrane on the crest of the plicae.

I was also in a position to observe an exposed surface of a mucous membrane from the colon descendens, in a prolapse of the colon in a colostomy, and could thereby ascertain that, in general, a richer forming of the folds appeared together with an increased contraction of the muscular coat, but that the mucous membrane even with very high folding could freely be moved against the underlying muscular coat; that a change of the folds of the mucous membrane as to the number, position and form took place, independent of the contraction of the muscular coat, and that purely local ridges of the mucous membrane have been formed without a corresponding local contraction of the muscular coat.

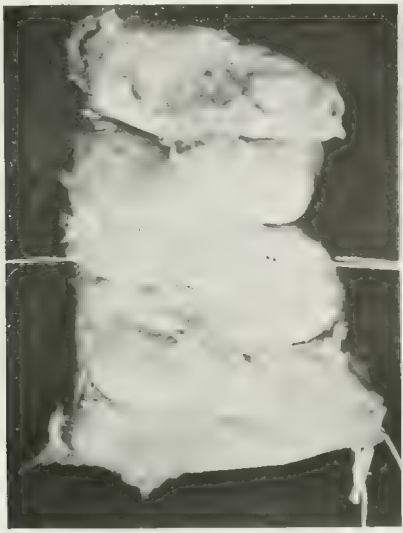


Fig. 27*a*. The outer surface of an anatomical preparation of a part of the splenic flexure.

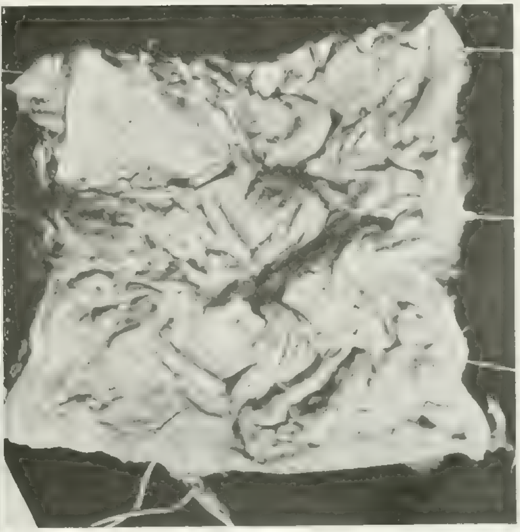


Fig. 27*b*. The mucous membrane of the same part of the splenic flexure.

It should, therefore, be without doubt that the folds of the mucous membrane, of the colon, as well as those of the stomach, duodenum and small intestines, are not modeled by a contraction of the muscular coat only, but by autonomous appropriate movements of the mucous membrane.

Although the relief of the mucous membrane can vary in a high degree in every part of the digestive canal, it is clear, however, that the mucous membrane in these parts has a certain tendency to form contraction-forms, typical for each part. For instance, the mucous membrane forms in the lesser curvature of the stomach; and even with the greatest shortening, there are no transversal folds, but longitudinal folds or a mammillated surface. The jejunum has a greater tendency to form a high and complicated relief of mucous membrane than the ileum, and the relief of the mucous membrane in bulbus duodeni is of a different type from that of the folds in the other intestines.

Where do we then find the motor forces of the mucous membrane?

The muscular coat (muscularis propria) models the exterior form and width of the digestive tube, but has no mechanical qualifications for a localized and individual folding of the mucous membrane, this membrane being freely movable against it. The muscularis mucosae forms the special contractible organ of the mucous membrane which, being attached to this one and to the submucous layer, is able to displace the mucous membrane in all directions by means of transversal, longitudinal and oblique fibers.

The mass of the mucous membrane, and, consequently, the volume of its folds, ought to be regulated by variation of the filling of the vessels, while number, posi-

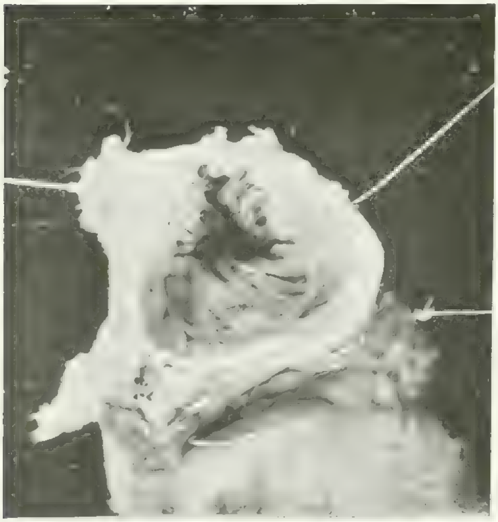


Fig. 28. Anatomical preparation of the mucous surface of the hepatic flexure.

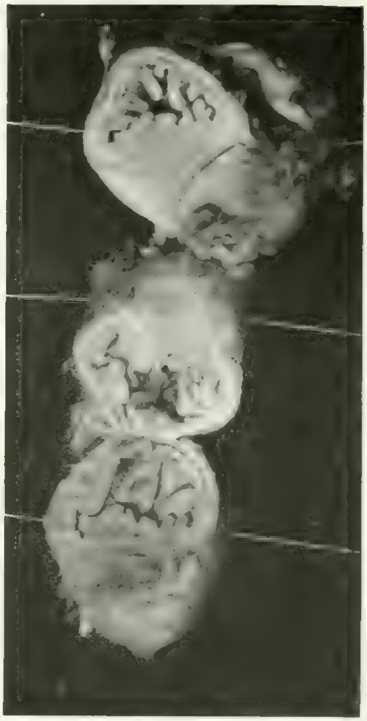


Fig. 29. Transversal sections of a strongly contracted sigmoid colon.

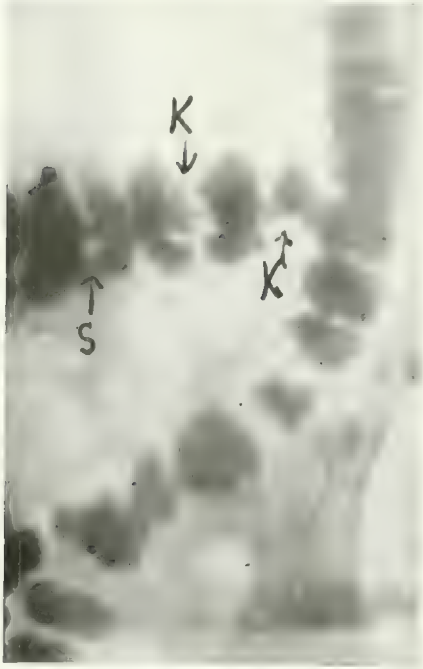


Fig. 30. Roentgenogram of the left part of a normal colon after contrast meal.

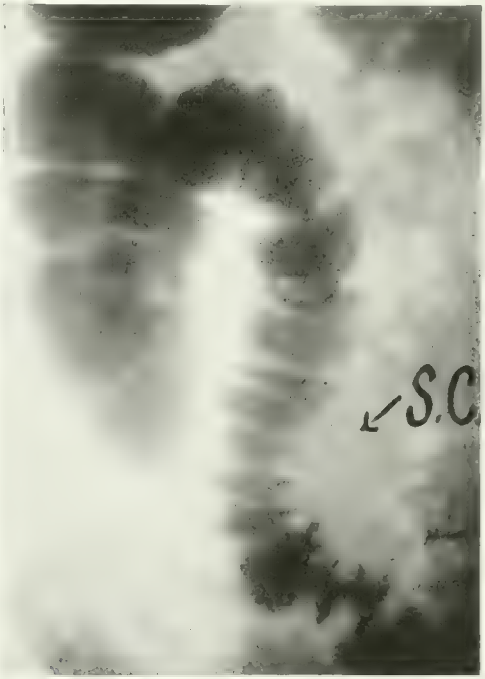


Fig. 31. Roentgenogram of a strongly contracted sigmoid colon filled by a contrast clyster. SC = Sigmoid colon.

tion and form of the folds are determined by the muscular system in the muscularis mucosae.

The forming of the high and close folding of the mucous membrane may occur more easily with a simultaneous contraction of the muscular coat (membrana propria), but a definite degree of contraction of the muscular coat does not produce a definite corresponding relief of the mucous membrane; on the contrary, a stage of contraction, producing a certain width of the muscular tube, can be associated with a relief of the mucous membrane varying from an even surface to a very complicated folding.

According to the present general opinion about the anatomical nature of the folds of the mucous membrane, an exclusively passive function is attributed to them, the folds only being supposed to have the purpose of enlarging the digestive surface and of preventing a too rapid flow of the intestinal contents. The knowledge that the folds of the mucous membrane do not consist of passive structures, but represent a momentary state of movement, must apparently involve a new appreciation of their function.

The whole rigid world of folds and furrows becomes alive and proves to be formed by independent motor forces which may be of great importance for the mechanical regulation of the digestion. It is apparent that the complicated relief of the intestinal mucous membrane not only forms a passive depository for digestion and resorption of the food, but also constitutes a mechanism with a subtle and wonderful organization for regulation of the chemistry of the digestion.

The muscular tube of the digestive tract and the special motor mechanism of the mucous membrane collaborate in the mechanism of digestion.

The movements of the muscular coat determine the rough division and the large displacements of the contents of the stomach and the intestines. The movements of the mucous membrane produce an extremely differentiated distribution and restraining of the food in digestive chambers of varying form and size, and procure the fine regulation of the current by the passage of the contents in the alimentary canal.

The rôle that disturbances of the motor mechanism of the mucous membrane may be playing in the pathology of the alimentary tract has not yet been investigated and great difficulties may occur in working out this problem.

At any rate, it is necessary, by studying the pathology of the alimentary tract, and, especially, by interpreting the roentgenograms of the intestines, to emphasize that the relief of the mucous membrane, not being a fixed structure, represents a state of autonomous movement.

Great experience and a thorough comparative investigation are necessary before we are able to distinguish the pathological types of the relief from the normal ones, and to separate the outlines formed by defects or infiltrations of the intestinal wall from the relief of a contracted mucous membrane. Probably new fields will be opened here for medical research.

DISCUSSION ON PAPERS OF DRS. BARCLAY, ALVAREZ AND FORSSELL*

Dr. Case. I feel, personally, much profited by hearing these entertaining and instructive papers. I feel very incompetent to offer any discussion on them. It is new light so far as I am concerned. I am particularly interested in Dr. Alvarez' work, because we all have had the experience in doing fluoroscopy of the chest and of seeing fibrillation and heart-block which are observed so nicely on the screen. I shall look forward with a great deal of interest to every development in this research.

It is also very interesting to note Dr. Forssell's work concerning the mucous membrane movements, which, in a measure, is confirmatory of some observations brought out by Cole.

---

* Papers read (those of Drs. Barclay and Forssell by title) at the Twenty-third Annual Meeting of The American Roentgen Ray Society, St. Louis, Mo., May 22–23, 1922. The paper by Dr. Barclay appeared in December, that by Dr. Alvarez in January, and that by Dr. Forssell precedes this discussion.

We are quite prepared to accept the propositions of both of these gentlemen and shall look forward to further interesting data along this line.

We are indebted also to Dr. Barclay for his contribution to the topic for this hour's discussion. I only regret that our distinguished foreign essayists were not able to be here in person.

Dr. Pirie. I think the society is to be congratulated on having such a paper as we have listened to. It is one of those things which we need so badly. We began the examination of the stomach long ago, and we have not reached fundamental principles as yet.

Dr. Alvarez mentioned the fact that the stomach responds to the duodenal rhythm. I have two slides which illustrate his remark. They are serial pictures of the stomach and duodenum, showing how the distal part of the duodenum contracts when the peristaltic wave in the stomach is approaching the pylorus. One would expect that the peristaltic wave in the stomach might be continued through the pylorus into the duodenum, but it is not so. A wave of peristalsis is seen to rise in the middle of the cap before the peristaltic wave in the stomach reaches the pylorus.

Dr. Moore. My inability and incompetence are greater than those of Dr. Case to discuss the details of any subject of this kind. Certainly those of us who have had the honor and pleasure of hearing Dr. Alvarez before knew we were going to be enlightened.

The society should be congratulated on having two such contributions from two prominent roentgenologists of Europe.

One of the weakest links in the chain of roentgenology today is the absence of any literature or definite knowledge of roentgen physiology, if it might be so expressed.

Dr. Alvarez (closing discussion). Dr. Forssell's work interests me because a good deal of work has been published of late in physiological journals on the contractions of the muscularis mucosae. The study of such puckerings may easily be of value, especially in diagnosing the presence of small ulcers on the anterior or posterior walls of the stomach. They show up well when there is just enough barium present to demonstrate the folds of mucous membrane.

Dr. Pirie's observations interest me very much because most of our graphic records show that the rush waves down the bowel generally originate in tonus contractions of the upper duodenum, and such tonus contractions seem to be due to the arrival of a wave of some kind, which travels out well ahead of the peristaltic wave in the stomach.

IMPORTANCE OF INDIRECT ROENTGEN FINDINGS IN CHRONIC INFECTION OF THE BILIARY DUCTS AND GALL-BLADDER*

BY M. P. BURNHAM, M.D.

SAN FRANCISCO, CALIFORNIA

HERETOFORE the roentgenologist has depended almost entirely upon the presence of calculi in the gall-bladder in the study of biliary tract infection for his findings. More recently, George has shown the possibility and importance of demonstration of the diseased gall-bladder itself, and has called attention to other manifestations of infection.

Chronic infection of the liver, bile ducts, and gall-bladder constitutes an entity, the characteristic feature of which is its chronic course. Calculus formation, duct blockage, etc., represent lesions of long-standing infection.

The present-day surgical literature stresses the fact of difficulty of recognition of even quite marked inflammation in gall-bladder by inspection and palpation of the organ at operation, the symptoms in these cases being of such severity as to have demanded operative interference.

This difficulty in recognition of disease processes of the biliary system with the abdomen open will explain the limitations of the direct roentgen findings.

The pathology of infection in liver and biliary system is a generalized one, in ducts and gall-bladder an interstitial process and not as formerly thought, largely made up of infection of contents of these organs. The biliary ducts are of narrow caliber, often anomalous in course, and offer difficulty to the passage of bile readily enough, when as a result of the infection the walls are thickened and the bile increased in density, the end result being stasis.

One of the three lymphatic systems of liver is in close relation with both cystic and common ducts, especially the latter, as it traverses the gastrohepatic omentum. These structures, in turn, bear a close relation with the distal aspect of the duodenal bulb and upper part of the second portion of the duodenum, being situated at that point posteriorly and with the medial aspect of the second portion

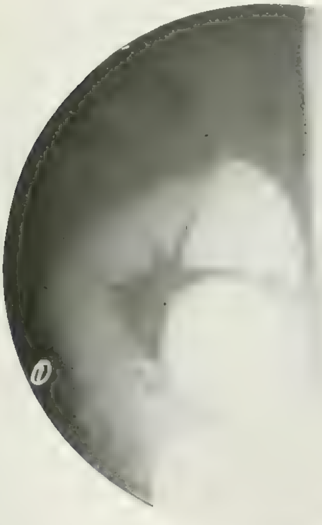


FIG. 1. Normal right oblique prone position.

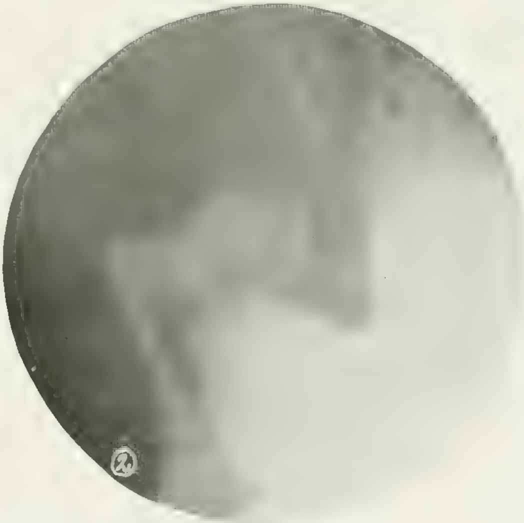


FIG. 2. Bulb deformity; angulation second portion of duodenum.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12-16, 1922.

lower down. In this region surgeons frequently at operation encounter distinct evidences of pathology about the ducts and neck of the gall-bladder when the fundus itself appears normal. Moreover, in attempting to mobilize the ducts and the neck of the gall-bladder and later in tying off, distinct evidence both of fibrosis of the ducts and the tissues about the ducts is demonstrable. Examination of the gall-bladder wall in these cases, on removal, gives definite evidence of infection. It has seemed to us probable that these earlier changes in and about the ducts and neck of the gall-bladder are associated with the beginning symptomatology presented by cases of chronic infection of the biliary tract. More and more surgery is being instituted in these non-calculus stages of duct and gall-bladder inflammation.

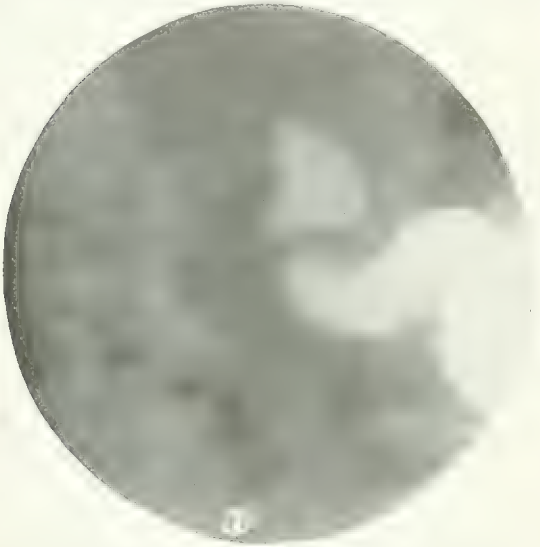


Fig. 3. Antrum spasm. Bulb indentation; angulation second portion.

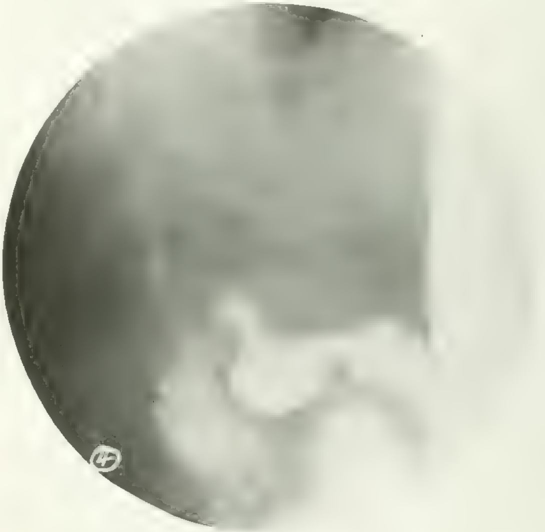


Fig. 4. Bulb deformity; angulation second portion of duodenum.

To limit our studies, therefore, to calculus demonstration by roentgen methods, even though they might be shown in 100 per cent of the cases when present, would highly restrict the usefulness of the examination.

However, the so-called indirect manifestations of duct and gall-bladder inflammation have been, in our hands, during the past few years, of increasing value in diagnosis. I feel that this evidence should be obtained independent of historical data.

The evidence itself may be divided into two groups: (1) Changes of form and position seen in the first and second portions of the duodenum, and (2) variations in the normal gastric physiology.

A few words regarding the technique of the examination: The ordinary opaque buttermilk meal is used, and we are accustomed to re-examine on the following day, utilizing an aqueous opaque meal for the gastrointestinal examination. The position of the patient in which the investigation is carried out is quite important. The standing position is not used on account of the drag of viscera under examination. The prone position also, as a result of pressure and overlapping of the various organs under study, is open to objection. We have found, by placing the patient in the prone position and by the use of the fluoroscope, turning the body toward the right lateral position, there appears at a certain angle, dependent on the individual habitus of the patient under examination, a position in which a clear profile view of the pyloric section and first and second portions of the duodenum is obtainable. In this position, any deformity of these sections can be best studied uninfluenced by pressure or traction from a normal source. In this position, the distal aspect of the bulb and the angle made as the bulb merges into the second portion are brought out in absolute clearness, the normal then being easy to establish. It is in these sections that we look for deformities, the result of biliary system pathology.

The angle of this right oblique position cannot be foretold in any case. A few degrees either way from it will militate seriously against its usefulness. It may be said that approximately 5 per cent of patients pass clear to the right lateral position. These are patients of sthenic habitus.

The first class of evidence, namely, that of change of form and relation in the first and second portions of the duodenum, and due to pressure mainly, although adhesion fixtures cannot be excluded as a cause, consists of clean-cut indentations of the duodenal bulb, crescentic deformities, usually seen on the lateral aspect of the bulb or on the inferior aspect; also irregular deformities of the bulb, not of the crescentic type, and distortion in the course of the descending duodenum amounting in many cases to very great angulation. These gall-bladder pressure deformities are, in a general way, much alike in all cases, changing as to the particular point in the duodenum at which the pressure is most prominently seen, dependent on the pathology present in the individual case. The angulations in the course of the second portion in the duodenum are quite as characteristic as the indentations in the bulb, in our experience.

The second class of evidence, namely, that of changes in the normal gastric physiology, is most interesting, but not nearly as decisive in character as changes noted in duodenum. It may be stated that the normal stomach accepts the liquid opaque meal, holding it in the form of a column of about equal width throughout, the pyloric sphincter closing, preventing its discharge into the intestine, and the cardiac sphincter closing, preventing regurgitation of the stomach contents into the esophagus.

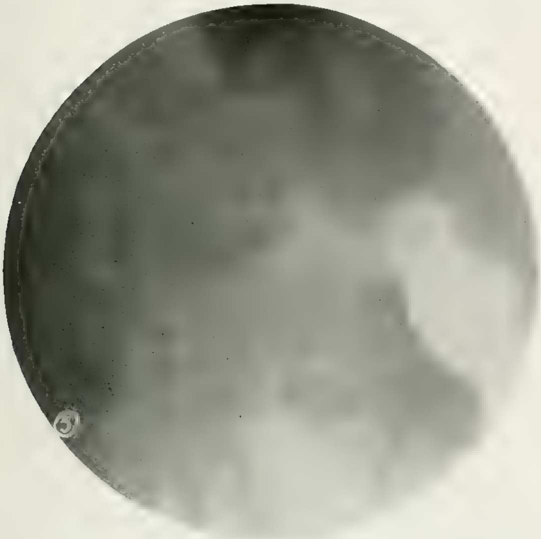


FIG. 5. Angulation second portion of duodenum.

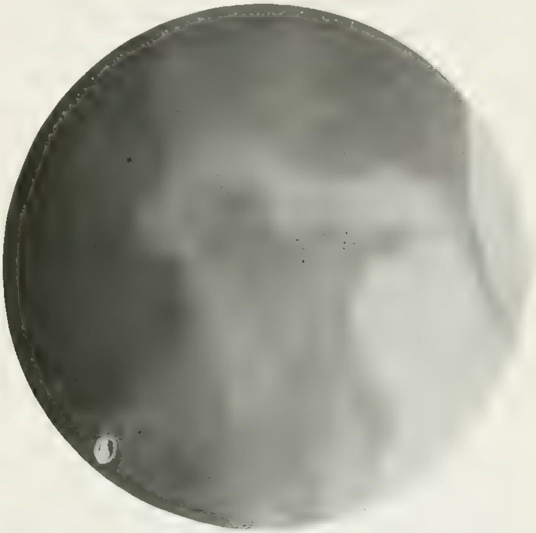


FIG. 6. Bulb deformity; angulation second portion of duodenum.

There is frequently seen, in cases of gall-bladder and bile duct infection, a narrowing in the pyloric end of the stomach produced by spasm of the wall, the stomach taking the form of a narrow-caliber tube. In other cases is seen a conical-shaped pyloric section, the result of spasm, with apex at the sphincter. This spasm appears immediately on taking a meal, and may persist for considerable periods of time. When the peristalsis is established, it is noted that the waves begin far back on the curvatures and traverse the stomach slowly, often failing to reach the pyloric sphincter. At no time has the antrum a globular shape such as we see normally.

This spasm of the pyloric section increases the intragastric tension and, I believe, is the cause of the sensation of the fullness and distention, of which patients complain.

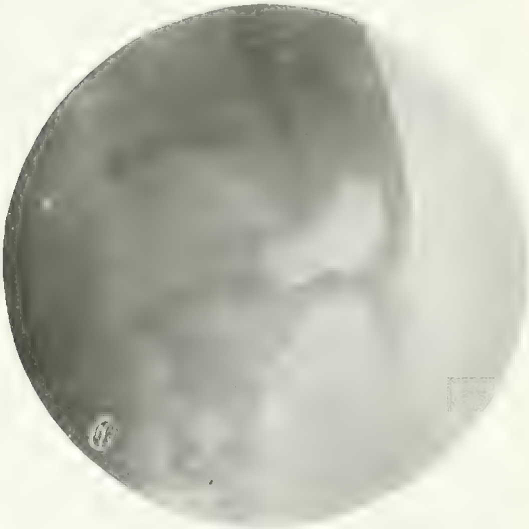


Fig. 7. Bulb indentation.

This increased tension may become so great as to overcome the normal constriction fibers in the cardiac sphincter, and allow the back-flow of small or even large amounts of the meal into the esophagus. The small amounts, in our experience, are usually returned at once to the stomach by peristalsis in the lower segment of the esophagus. It has appeared to us that in some cases the loss of the sphincter control mechanism has passed a point where intragastric tension may no longer be the cause of its occurrence, but that an actual inhibition of the constriction fibers has resulted, and the meal will flow to and fro from stomach to esophagus with little or no retardation at the sphincter. When this condition of complete, or nearly complete, divulsion of the cardiac sphincter is seen, it is necessary to exclude, as a cause for it,

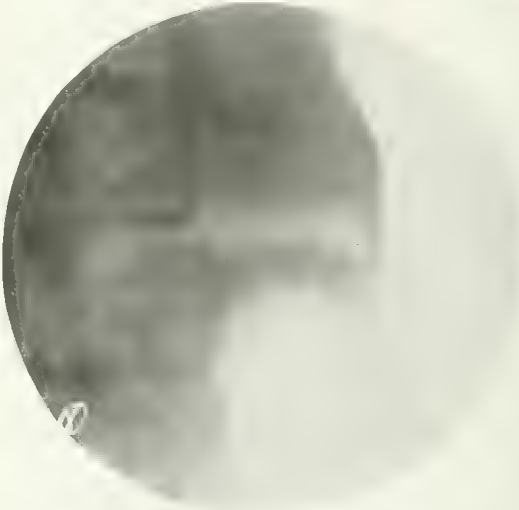


Fig. 8. Bulb deformity, angulation.

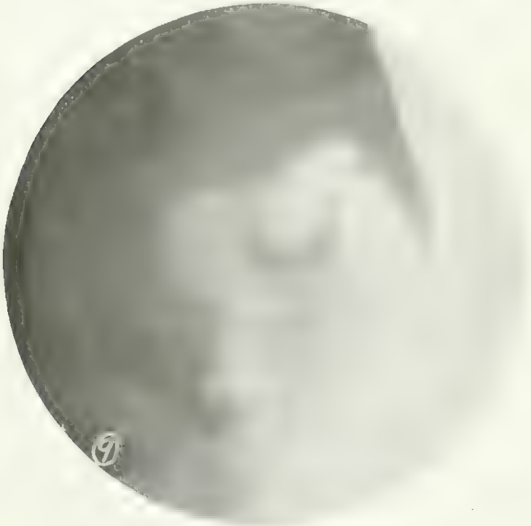


Fig. 9. Bulb deformity, angulation.

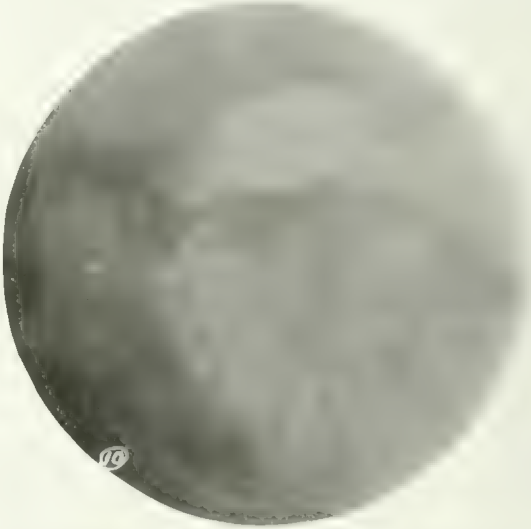


Fig. 10. Deformity on medial aspect, second portion.

any organic lesion of the gastrointestinal tract which may cause the condition.

Pyloric spasm of the type described is more commonly seen than the sphincter change at the cardia.

Of the two classes of indirect evidence, that of deformities in the two portions of the duodenum is of far greater importance than that made up of gastric physiological abnormalities. It has seemed to us, however, that the disorders of physiology may appear before any of the findings brought about by pressure or fixation in the duodenum.

We have made use of these indirect findings as an aid in the interpretation of doubtful demonstration of the gall-bladder on films. If the gall-bladder region contains a contour line in itself not determinate, it is given much greater weight in the final summing up of all available data, if attended by these indirect manifestations.

In differential diagnosis, the presence of abnormal peritoneal bands has been confusing in some cases. In a general way, however, these structures, as shown by Cole in a paper read before this society last year, have distinctive features quite different from those obtained due to lesions of the biliary system.

Several cases of ulcer of the duodenum with old perforation, resulting in fixation of bulb and irregularity of contour not of the usual type of that of ulcer, have been seen, in which it was not possible to exclude a gall-bladder lesion, the primary diagnosis being ulcer. At operation these cases have been found to be free from evidence of gall-bladder infection.

Indirect findings have made it possible to show frequently the presence of both ulcer and gall-bladder pathology in the same case. Recognition of the gall-bladder lesion, not uncommonly associated with both pre- and post-pyloric ulcer, but commonly not found by the roentgenologist, allows of consideration by the surgeon before operation, and often ends in a more orderly method of surgical attack.

In conclusion, I would emphasize the fact of the importance of the indirect roentgen evidence in the study of the earlier stages of biliary infection. I believe also that its importance at any stage far outweighs that of the direct findings.

DISCUSSION

Dr. George. It is a great personal satisfaction, both to Dr. Leonard and myself, to know that Dr. Burnham has carried on this work and has not only substantiated what we have tried to bring out in the past, but has gone a little further by emphasizing the secondary or indirect signs which determine more accurately pathology of the gall-bladder. The more we do of this work the more we realize that it is a relatively simple problem. As you all know, we have attempted to make visible the gall-bladder, and we still think that if we can accomplish it, the gall-bladder is pathological; no one has proven to the contrary so far.

In our efforts to make visible the gall-bladder we have come to depend on other signs, the same signs, practically, that Dr. Burnham has emphasized today. In the last year, especially with the use of the Potter-Bucky diaphragm, we have found secondary changes very constant. This, perhaps, we have overlooked earlier in our work, for we did not in the past attach the significance to these changes which we do at present.

As we go over this work, we find that the pathological gall-bladder almost invariably shows an impression on some portion of the stomach or duodenum, or changes in the second portion of the duodenum. The question has come up time and again why this should be.

Some of you have probably had the same experience that we have with surgeons who ask why should not a normal gall-bladder show, as we claim the pathological gall-bladder will, against the stomach, or first or second portions of the duodenum. If you ask them in turn for their diagnostic sign or signs, or what to them means a normal gall-bladder without opening it, you invariably have the reply that the gall-bladder was found easily compressible, or contents expressible without difficulty; that is, as far as palpation is concerned.

The reason, it seems to us, that the pathological gall-bladder shows this outline on the duodenum and other portions of the gastric tract is that the tension within the gall-bladder is greater than in the normal, and that it is greater than the amount of bismuth that passes around it. If this is the cause, then there must be considerable tension to accomplish this result.

In the exhibit which we have made at this meeting, we have chosen the most characteristic examples of pressure defects upon the various portions of the stomach and duodenum. There is one point in diagnosis which seems not so much a question of pressure defect, as we have tried to explain it, due to the gall-bladder, but rather that there is a concave body which is in contact with the stomach or duodenum, and produces at the point of pressure or contact a "half-shadow." This visualization means a concave surface that must produce this change. As you will see in every instance where the gall-bladder is actually in contact with the stomach or duodenum, there is a difference in shade or density of the bismuth mass immediately at the point of contact, and it takes only a moderate amount of imagination to visualize that this is due to a globular mass, causing this pressure.

Again, we are, naturally, with the experience that we have had, impressed by the normal appearance of the stomach and duodenum, first and second portions. Unfortunately, or, perhaps, fortunately, both of us, Dr. Leonard and I, being more or less single-tracked in our ideas, have carried on our gastrointestinal examinations in exactly the same way for the last ten years. We have never changed the meal in any way, or the technique, or the time of examination, and in no instance have we ever attempted the double meal as a method.

Taking the number of cases that we have done in the past, we very quickly with our technique can determine, and, we think, accurately, the normal, anatomical position of the duodenum; and any variation from this, where the second portion of the duodenum seems to be at right angles to its normal position, immediately opens the possibility or probability of the cause of this being adhesions arising from or about the gall-bladder. This is one of the common signs, indirectly, of gall-bladder disease. It is practically accepted by all pathologists that adhesions arising from the gall-bladder, or in any way connected with the gall-bladder, are due to disease within the gall-bladder, either past or present. This is a very definite sign.

These signs may not necessarily be found in one position. Sometimes they are found entirely in the anteroposterior position, and at other times, only in the lateral position. We have found, by talking with various roentgenologists, that very few attempt the true lateral position routinely. In every case we do as many laterals as we do the other positions, and it is probably the most important position, everything considered.

Depending, as we do, mainly on films for our evidence of gall-bladder disease, it is possible that in omitting routine fluoroscopic examinations of the stomach, we are overlooking some of these extra signs that Dr. Burnham has so clearly brought out in his paper, especially spasm. Carman first mentioned spasm to us, and after a long time of searching for evidence of this spasm, we found one case which not only showed gall-stones, but showed the characteristic changes in the antrum of the stomach that Carman mentions.

We have termed these pressure signs on the stomach and duodenum as indirect signs. As a matter of fact, they should be called direct signs, or at least, secondary, and spasm is unquestionably a secondary problem. Unless one has had a good deal of experience with the normal and with disease of other portions of the gastrointestinal tract that do produce spasm, one may be led astray, unless extremely cautious, in using spasm as an important sign. I think Dr. Burnham from his experience is in a position to emphasize this sign even more than we.

It has been a great personal satisfaction to have heard Dr. Burnham's paper because it has been instructive, and I am sure that my coming visit to Dr. Burnham in San Francisco will emphasize more strongly even than he has today the importance of these signs that he has mentioned to us.

Dr. Case. I have enjoyed Dr. Burnham's paper very much and have enjoyed still more the splendid roentgenograms which he has set up in the Scientific Exhibit. I have been very much profited by the further contribution to this subject which he has made.

With Dr. George and his colleagues, I have for a number of years held that the shadow of the gall-bladder, when definitely determined upon the roentgenogram, was a sign of a pathological gall-bladder. On several occasions, in my surgical work on patients whose roentgen examinations showed an indisputable gall-bladder outline, I have found the gall-bladder to be easily compressible and the contents easily expressible; the gall-bladder wall being thin, with no enlarged glands about the cystic or common ducts, and with no pericholecystic adhesions. On account of the history, I felt that I was justified in removing the gall-bladder in these cases; and when the gall-bladder was later opened, it proved to be definitely diseased. I would like to show you slides of a number of such gall-bladders, showing, in one instance, 100 or more grains of small black biliary sand; in several other instances, papillomata of the gall-bladder which were easily made out with the naked eye. We have also made bacteriological studies of the bile from the gall-bladder and cultures of macerated portions of the mucosa of the gall-bladder from both fundus and neck in a number of these cases. I am frank to say that I have seen a fair number of cases where, in spite of very distinct delineation of the gall-bladder on the roentgenogram, I have not felt justified in removing the gall-bladder. I feel that we can only go so far as to say that the distinct outline of the gall-bladder in the roentgenogram suggests pathological gall-bladder and may be considered as a contribution to the evidence going to condemn such a gall-bladder.

I feel that it is very important to emphasize that before making a diagnosis of visualized gall-bladder, we must identify the shadow of the right kidney and the shadow of the lower edge of the liver; the gall-bladder outline must be a third shadow. I think a great many kidney outlines have been mistaken for enlarged gall-bladders.

Another point is the question of indentation on the duodenum, which is presumed to be made by a distended gall-bladder. I feel that this does not *prove* gall-bladder pathology; it only suggests it. I am perfectly certain that the normal gall-bladder can make such indentation. I think we may say only this: that it contributes to the diagnosis, but that of itself it certainly is not pathognomonic.

We have made a summary of something over 350 consecutive cases of gall-bladder disease where the gall-bladder was either removed or drained surgically; the operative findings have been compared with the findings of the direct or indirect *x*-ray signs. We were able to make an *x*-ray diagnosis of gall-stones in 32 per cent of the cases in which stones were found at operation; but the indirect signs such as I have been employing for years, and such as have been outlined by Dr. Burnham in his excellent paper today, were present in 88 per cent; so that I feel that the indirect *x*-ray method is certainly a very dependable method of contributing to gall-bladder diagnosis.

After long experience in this thing, and after considerable effort to prove that the gall-bladder when visualized is always pathological, I am free to state my conviction that this is not always true, and that the duodenal indentation may be made by a temporarily distended normal gall-bladder. The gall-bladder is normally distended when one holds the breath, and usually these roentgenograms are made while the breath is held.

Dr. Alvarez. I want to congratulate Dr. Burnham on his paper, which, I think, marks a definite advance in our knowledge of the subject. His plates are beautiful and they fill me with the hope that we may be able to diagnose more of these diseased gall-bladders. I still, however, cannot quite accept some of his conclusions.

I do not see how a roentgenologist who takes no history and who does not follow up the patient after operation can tell whether these indenting gall-bladders are diseased or not. I take a most careful history, I make a physical examination, I screen the patient and study the plates. Then, if the patient is operated upon, I see the gall-bladder, I take it to our University bacteriologist for cultures from the bile and the ground-up wall, and I study sections with the pathologist. Later I follow the patient up to see if there is relief from symptoms. I do not see how any one can have a right to strong opinions until he does that sort of thing. What I have learned is that a symptom-producing gall-bladder with its wall full of bacteria is often soft and absolutely normal to the touch. I agree with Dr. Judd of the Mayo Clinic that in order to give these patients relief we must often remove the organ, simply because the history points so strongly in its direction. If we cannot recognize many of these diseased gall-bladders by visual and tactile examination, how can we ever hope to recognize them roentgenographically?

Dr. Moore. I would like to congratulate the essayist on his paper.

We have done, I am sorry to say, little gall-bladder work in depending to any degree on direct or indirect evidence. I would like to ask Dr. Burnham in regard to indirect evidence—spasm; whether he has seen a six-hour retention in the stomach as the result of gall-bladder disease, and whether or not these deformities are influenced by antispasmodics, such as belladonna.

We feel that the gall-bladder is a big part of gastrointestinal diagnosis, not so much from the roentgenological standpoint as from the general clinical picture of digestive disturbances.

I was glad to hear Dr. Alvarez mention the difficulty of determining what constituted pathology of the gall-bladder while it was in the patient. It seems to me that in these cases the attitude is pretty well expressed by what I recently heard one surgeon say: that in exploring a case in which the diagnosis had been doubtful, and in which the examination was doubtful, the appendix might be regarded as the first-line trench—first the appendix and then the gall-bladder.

It is remarkable to me, and a source of extreme gratification in following cases, to find what extreme relief some of these digestive disturbance cases obtain by removal of the gall-bladder.

If we can obtain definite or other signs in the duodenal bulb, and if the gall-bladder will produce these signs, then the roentgenologist is going to offer assistance to the general diagnostician and surgeon.

Dr. Hickey. I would like to ask Dr. Burnham whether he extended his studies toward secondary signs with regard to the colon, whether he found any deformity in connection with the hepatic flexure and whether he finds a tendency to stasis in the cecum.

Dr. Burnham (closing discussion). I have not noted anything in the colon as to stasis. I have not gotten any help out of the six-hour retention and really do not recall whether or not it occurs at all frequently.

The title of my paper was meant to express what I was trying to get at. I have been unable to demonstrate stones with any satisfaction except when a man would say, "I know this case has stones." In many veteran cases of this sort, stones can be made out by us.

Since we have undertaken this work, the visits to the operating-room have become a great pleasure, and I have seen as many as 3 cases of non-calculus cholecystitis surgically treated in a morning's work.

I have been interested in the clinical check, although I have never been able to follow my cases closely, but repeatedly I have gotten in touch with patients six months after operation, and have been surprised at the relief obtained from removal of the gall-bladder.

The point I wish to emphasize is the importance of making investigations and putting down findings in a clear-cut way, in order to help the man who is consulted by the patient with obscure symptoms.

AN X-RAY STUDY OF THE ABSORPTION OF TUBERCULOUS EXUDATE WITHIN THE LUNG*

BY KENNON DUNHAM, M.D., AND VERA V. NORTON, M.D.

Cincinnati Tuberculosis Sanatorium

CINCINNATI, OHIO

THIS is primarily an *x*-ray study. To us it conclusively demonstrates that tuberculous exudates are frequently absorbed. Many of the lesions observed have been tuberculous caseous bronchopneumonia in far advanced cases. We believe that absorption is even more common in early apical lesions, but such cases are uncommon in the Cincinnati Tuberculosis Sanatorium. If such absorption were compared with that following the consolidation of a frank pneumonia, it would be called slight and infrequent. We have limited this report to cases observed during the single year, July, 1921, to July, 1922. Absorption of tuberculous exudate was noted in 59 cases out of a total of 489, or more than 12 per cent of those examined. This was a striking observation to us, as it was neither slight nor infrequent.

The generally accepted idea of the healing of tuberculosis is thus expressed by Delafield and Prudden: "Small foci of tuberculous inflammation which are called miliary tubercles may, as we shall see later, extend and coalesce so that with more or less exudative pneumonia, large areas of the lung may become consolidated, thus developing one of the forms of pulmonary tuberculosis called phthisis. On the other hand, small tubercles in the lung may, with or without extensive necrosis, become surrounded by, or converted into, masses of dense fibrous tissue. These fibroid masses, which are often called "healed tubercles," may contain necrotic material, are often mottled black from anthracotic pigments, or may be calcified at the center."

This is again stated by Ziegler: "It is very doubtful whether complete recovery of the affected tissue by re-absorption of the exudate is in any case possible, and indeed, it can only occur in the very smallest patches whose vessels are not yet obliterated. In larger patches, healing can only take place when the inflammatory process issues in fibrous hyperplasia and induration."

However, in 1858, Virchow stated: "The cheesy transformation is the regular termination of the tubercle, but, on one hand, it is not the necessary one, inasmuch as there are rare cases in which tubercles, in consequence of their undergoing a complete fatty metamorphosis, become capable of re-absorption; on the other hand, the same cheesy metamorphosis befalls other kinds of cellular new formation, for pus may become cheesy, and likewise, cancer and sarcoma."

---

* Read by title at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., September 12–16, 1922.

In 1922, Gardner proves: "Caseous tubercle can heal by resolution and finally disappear completely." The basis of this report is the work of Dunham and Skavlem, who state in their conclusions that "certain *x*-ray densities suggest definite cellular pathology." We accept this research as correct and go a step further and claim that certain *x*-ray densities not merely suggest, but may be definitely read in the language of cellular pathology.

At some future time, a more complete report of these autopsies will be made. This report is based upon gross pathology. Sixty-four autopsies were held during this fiscal year. Nine of these were not *x*-rayed before nor after death; 34 cases were *x*-rayed before death, and densities of caseous bronchopneumonia were read from the plates. These were found by the pathologist in the lobes as described. In the 35th case, caseous bronchopneumonia was found in limited areas by the pathologist, but three months before death, the roentgenologist did not observe this.

Fifteen cases had no chest plates made during life, but comparison was made between the roentgenologist and the pathologist by means of lung plates made after death. Fourteen of these tallied. One did not agree: The pathologist's diagnosis was bronchopneumonia due to tuberculosis; the *x*-ray diagnosed bronchopneumonia probably not due to tuberculosis. In 5 cases, death was from causes other than pulmonary tuberculosis. The pathologist and roentgenologist agreed completely in these 5, but no caseous bronchopneumonia was found.

We believe that a study of these autopsies justifies the conclusion that caseous bronchopneumonia can be detected from the *x*-ray plate. This justifies the statement that certain *x*-ray densities may definitely be read in the language of cellular pathology.

The proof of this claim rests, then, on this comparison of *x*-ray plates and the autopsy findings in 55 cases, and on a study of 59 cases still living, that have shown the same densities in *x*-ray plates which have disappeared coincident with a clinical improvement.

It is interesting to look back over our work and watch the evolution of this idea. In May, 1920, we find this note in the history: "The caseous bronchopneumonia is not so dense as shown by the plates six weeks ago." Similar readings occur with increasing frequency until, in February, 1921, the following was noted: "These plates show to what extent caseous bronchopneumonia can clear up." From May, 1920, until July, 1921, such observations were recorded some 20 times. We have limited this study to cases observed from July, 1921, to July, 1922. Some of the cases had been observed many years previously, but the routine of the hospital brought every one of these cases to our attention during these twelve months. None were dragged in, and many interesting examples were left out because they did not come to us by routine.

In all, 489 cases were examined; *x*-ray densities diagnosed as exudate decreased or disappeared in 67 or 13.7 per cent. Eight of these were not proven tuberculous, leaving a little more than 12 per cent. Of these 8, 4 had 4+++++ Wassermann; 2 were finally proven interlobar empyema, and the remaining 2 were very atypical, and an etiological diagnosis of the supposed exudate was not made.

Fifty-one cases had positive sputum sometime during their residence. Thus, we have diagnosed 8 as tuberculous without positive sputum. Three of these are positive from the history, symptoms, physical findings and *x*-ray examinations, but tubercle bacilli have not been found in the sputum. Three young children had no sputum. The physical signs are suggestive, but history, symptoms, *x*-ray plates and Von Pirquet are very positive. One young girl had no sputum, but had typical fans of differing densities, characteristic of tuberculosis, which have disappeared in one part of the lung only to appear in another. One adult had no sputum, but otherwise, the diagnosis is beyond question. We unhesitatingly diagnose these 59 cases as pulmonary tuberculosis.

As was expected, sex seems to have no special influence: 42 cases or 71 per cent being males and 17 cases or 29 per cent being females, the proportion in 489 being 69 per cent and 31 per cent.

Regarding ages, of the 489 cases examined, 278 or about 57 per cent were over thirty. Of the 59 cases showing the absorption of caseous bronchopneumonia, 38 or about 64 per cent were over thirty. This may indicate that this change is increasingly frequent with advancing age.

We were interested, though not surprised, at the findings regarding race. In the period during which these observations were made, plates were made of 489 cases. Of these, 384 or 78.5 per cent were white, and 105 or 21.5 per cent were colored, but of the 59 cases in which absorption was noted, only 2 or less than 2 per cent were negroes. One of these is a negro boy, admitted in July, 1915, aged eight. The diagnosis on admission was incipient pulmonary tuberculosis with a slight lesion in the upper left lobe. He has been re-admitted 4 times since, and through a series of 6 *x*-ray examinations, we have watched this lesion develop. A cavity has formed and caseous bronchopneumonia has appeared. In the last set of plates made on July, 1922, the cavity is very clearly defined by a thick wall while the exudate is being absorbed. The other negro shows only slight absorption.

In classifying these 59 cases as to degree of absorption, we have noted:

7 in which the change was slight
24 in which the change was moderate
18 in which the change was marked

The remaining 10 are left in a class by themselves, because, while the caseous bronchopneumonia has been absorbed at some time during the period of observation, seeming to indicate improvement, in other parts of the lungs retrogressive changes, most frequently the increase in size of a cavity, have occurred. Three of this class died during the year.

Case I. White male, aged forty-seven. When first admitted, in July, 1913, had a history of illness dating six months previously, moderate cough, little sputum (negative) slight hemoptysis, temperature in July, 98 to 104.6° F., becoming less on usual rest treatment. Was given protoiodide of mercury because of luetic history.

Roentgen Examination. Plates No. 429, made October 6, 1913, show marked involvement of the right side with probable cavity. Left did not show much pathology. Pneumothorax treatment was begun and Plates No. 438 made October 14, 1913, 481, 505, 515, 524, February 8, 1914, illustrate phases of this collapse. He received in all about 15 treatments. When he was discharged, in May, 1914, at his own request, he had gained 13 lbs. and his temperature had been below 100° F. for three months.

Re-admitted September 26, 1914. Had continued to improve. "Breath sounds have returned to the right side and were heard all over the chest." No plates at this time. Was in hospital until January 9, 1915. French leave.

Re-admitted August 6, 1915, with temperature of from 97 to 103.4° F. Had lost 17 lbs. Again improved and again took French leave, January 11, 1916.

Re-admitted November 15, 1916, in fair condition, gaining in weight. Plates 1092 show oldest lesion in the upper right; dislocation of the thoracic viscera upward. Lesion in left vertebral trunks. French leave, February 1, 1917.

Re-admitted August 26, 1919. Wassermann negative. Sputum negative. Signs of cavity in the upper right. Again improved and again took French leave two months later.

Remained out until July 26, 1920. On re-admission, sputum was positive and Wassermann negative. Physical signs on both sides, more marked on right with cavity. Temperature 96 to 100° F. Weight 115 lbs.

Roentgen Examination. Plates No. 1860, made October 24, 1920, show benefit of pneumothorax which has definitely arrested the lesion in the upper right, allowing greatly increased fibrous tissue to develop around the upper right, so that when this lobe broke down, with cavity formation, the lesion was well walled off and drained well. Definite lesion seen in the upper left and definite mottling suggesting caseous bronchopneumonia from the third rib to the fifth interspace and, to a less extent, in the lower right. Again improved and again took French leave December 1, 1920.

Three times has this story been repeated, his last admission being on July 26, 1922. Wassermann is now positive and the sputum contains tubercle bacilli.

Roentgen Examination. Plates No. 3139 show the large cavity in the upper right with heavy capsule and thickened pleura drawing the trachea over. With this, a definite decrease in caseous bronchopneumonia is noted in the lower and middle lobes. There may be beginning caseous bronchopneumonia in the lower left.

Case II. White male, aged thirty. Admitted June 26, 1921. History of pneumonia in infancy and again five years ago. "Subject to bronchitis and bad colds" since. Twenty to 30 lbs. underweight. Severe cough with expectoration, worse at night. Positive sputum; negative Wassermann. Temperature very irregular —in the evening 98.8 to 101.6° F. within two weeks; pulse also irregular. Physical signs indicated scattered areas of involvement. A diagnosis, confirmed by roentgen examination, Plates No. 1778, made August 18, 1920, showed a slight lesion in right vertebral trunks; confluent caseous bronchopneumonia, first and second interspace trunks; slight involvement apex of lower right. Heavy tuberculous fans in the anterior branches of the vertebral trunks, left side; faint cloud due to tuberculous pneumonia, but not *caseous*, in the posterior branches of the first interspace trunks; area of caseous bronchopneumonia in the anterior branches of the second interspace trunks.

Patient improved; temperature and pulse more steady; gained 24 lbs. in weight in the two months before he took French leave. Was out only eleven days.

Roentgen Examination. Plates No. 1902, made December 12, 1920, four months after the first set, show the absorption in the upper right with the development of a cavity. A similar change has occurred in the left lung. Cavity has developed behind the second interspace. The fans in the vertebral and first interspace trunks show decreased density, and the fan in the second interspace trunks is more blotchy, suggesting caseous bronchopneumonia rather than caseous pneumonia. Physical signs are much more marked, but no evidence of cavity is found. In March, the patient again took French leave, remaining out three months.

His third period of residence lasted from June, 1921, until February, 1922, when he went to New Mexico. Plates No. 2736 show great change in the right lung. There is now an area of emphysema in the vertebral trunks above the clavicle. The first interspace trunks show evidence of increased scar tissue which may be the result of contracted cavity. Linear markings of the second interspace trunks are now obscured by a faint cloud, but no caseous bronchopneumonia is noted. In the left lung, the vertebral trunks are heavy, as are the posterior branches of the first interspace trunks. An area within the second interspace trunks now shows a cavity. In the lower left, near the angle of the scapula, there is still increased density, but not as heavy as before.

Case III. White male, aged twenty-eight. Admitted February 26, 1921. Typical history of pulmonary tuberculosis. Sputum positive.

Roentgen Examination. Plates No. 2064, made March 3, 1921, show pulmonary tuberculosis chronic, fibroid, active, far advanced; adult, apical type. Unusual abnormal density seen behind the third rib, upper right, which appears to be a cavity surrounded by caseation. Caseous bronchopneumonia in the right base. More recent fans in the upper left. Prognosis very grave; will probably not live over a year.

Roentgen Examination. Plates No. 2134, made April 8, 1921, show that infiltration throughout the right, especially in the lower lobe, is much less; not so marked in the left. Cavity not now in evidence, but great masses of increased density are seen in the upper and lower lobes. The lesions lie much higher. This may be due to the extent of inspiration, or to a dislocation of the thoracic viscera due to absorption of exudate and contracted tissue. Temporarily, the prognosis is better.

Roentgen Examination. Plates No. 2218, made May 21, 1921, show most unusual absorption of exudate throughout both lower lobes, especially the right. The upper right now seems to contain two large cavities which have been compressed by contractile tissue and thickened pleura. Thickened pleura between the upper and middle right lobes and drawn up so that it lies behind the third rib. The fan in the upper left has been absorbed. Two areas of lesser density, which might be beginning cavitation, are seen behind the second rib, upper left.

Roentgen Examination. Plates No. 2540, made October 22, 1921, show that the thickened pleura now lies behind the second interspace. The cavities are so contracted that they would probably be overlooked. Very little further absorption.

Roentgen Examination. Plates No. 2786, made March 9, 1922, show trachea to the right. Thickened pleura between the upper and middle right lobes is still made out behind the second interspace. Cavities have disappeared, and in the upper right, only a massive fan is noted in the first interspace, and some mottling at the apex. Great absorption of exudate is noted in the upper right. Abnormal densities in the middle right behind the third rib, which suggest caseous bronchopneumonia. The massive caseous bronchopneumonia in the lower right has almost entirely disappeared. Delicate fans are made out in the vertebral and first interspace trunks only, and the exudate in the second interspace trunks is almost absorbed.

Clinically, the case has shown marked improvement. Was admitted with temperature from 97 to 102 and 103° F.; weighed 137 lbs.; sputum positive. He now seldom has a temperature of over 99° F. and weighs 152 lbs. Sputum negative last month on several examinations. Rales, formerly heard throughout, except at the left base, are now very few, and confined to the upper lobe.

Case IV. White male, aged twenty-three, (Filipino). Admitted October 8, 1920. History of "colds" for several years. Slight hemorrhages for the past year. Very little cough. Wassermann negative. Sputum negative on admission, positive once, about a year later, after a series of hemorrhages.

Roentgen Examination. Plates No. 1854, made October 21, 1920, show lesions involving the entire right lung. Old fibrous fans in the right apex and in the first interspace trunks of the upper right. Caseous bronchopneumonia noted in the second interspace trunks, upper right. The middle and lower right lobes are studded with small confluent areas of caseous bronchopneumonia. Some in the lower left, but not so extensive. Bronchiectatic cavity is suggested in the first interspace trunks, upper right.

Roentgen Examination. Plates No. 2020, made February 9, 1921, show that the lesions in the upper right are less fan-like. The mottling is much finer in the middle and lower right lobes. The cavity is still present. Six months later, during three days (August 3rd to 6th) lost about 50 oz. of blood. Temperature for about ten days, 101 to 100° F.

Roentgen Examination. Plates No. 2633, made December 3, 1921, show that lesions on the left side have entirely disappeared. The right side shows great absorption. Definite fan seen behind the first rib and clavicle; probably the first interspace trunks contain two bronchiectatic cavities. Fan in the second interspace trunks, coming to the surface under the fifth rib. In the middle right an unusual area of increased density involves the linear markings of the upper branches of the trunks coming to the surface in the third interspace, anterior axillary line. The rest of the lobe is emphysematous. Further absorption is noted in the plates of February, 1922. Not reproduced.

Case V. White female, aged twenty-two. First plates were made elsewhere in December, 1919, and read at the Cincinnati Tuberculosis Sanatorium. No. 1763B. Plates are thin, and it is impossible to exclude a tuberculous lesion in the left apex. In the second interspace trunks, upper left, there is a large mass of exudate containing a cavity.

Roentgen Examination. Plates No. 1763A, made in August, 1920, eight months later. These plates show definite lesion in the upper left as suggested above. Definite diagnosis not made from the plates, because the cavity is unusually large for the amount of fibrosis in the apex. Sputum, a few days later, contained tubercle bacilli, only positive during period of observation. Patient was admitted August 10, 1920, and three weeks later was transferred to Ohio State Sanatorium, where she remained under treatment for thirteen months.

Roentgen Examination. Plates No. 1925, made December, 1920, about one year after the first set of plates, show definite lesion in the left apex. Cavity in the second interspace trunks has been replaced by an irregular mass of increased density immediately behind the second interspace. This contains several small areas of decreased density, which might be contracted cavities.

Roentgen Examination. Plates No. 2361, made July, 1921, show a density in the second interspace trunks, upper left, indicating more fibrosis; and the lesions in the vertebral and first interspace trunks seem more active. Increased activity in the right vertebral trunks; decrease in the second interspace trunks.

Roentgen Examination. Plates No. 2599, made November, 1922. The exudate in the second interspace trunks, upper left, has been absorbed to a large extent. The cavity is now more definite and suggests greater fibrosis. The fans in the right apex and second interspace trunks, upper right, are much more definite. Patient continued to work with no symptoms of tuberculosis until early in February, 1922, when she suddenly developed pain in the right side with dyspnea and coughing spells, but no sputum. Temperature 103.2° F.

Roentgen Examination. Plates No. 2767, made February 22, 1922, show that the most striking change is the hazy density over the right base. There is evidence of thickened pleura over the entire right side and between the upper and middle right lobes. The diaphragm is drawn up and attached to the lateral wall. The fan previously noted in the right apex is heavier. The fan in the second interspace trunks is obscured by the haziness just described. It is impossible to determine whether the density is wholly due to lesions within the pleura, or whether the pleuritis is the result of inflammation within the lung. The lesion in the left lung has cleared up remarkably. A definite fan still remains in the vertebral and in the first interspace trunks, but the cavity has greatly contracted, so that it now seems to be bronchiectatic. The heart is not drawn to the right. Needle was introduced into the chest, but no fluid was obtained. The temperature came down very quickly and in about a month, became normal. The patient was discharged April 1st, and returned to work.

Just before discharge, Plates No. 2847 were made. The fans described on the right side are now seen only with difficulty. There is still some pleural thickening between the upper and middle right lobes. The diaphragm is attached to the anterior, lateral and posterior walls. The lower and middle right lobes are compressed by thickened pleura. The heart is now beginning to be drawn to the right. Definite thickening of the linear markings of the middle and lower right lobes.

Primarily, the lesion at the right base is a pleuritis. The extent of the inflammation within the lung is not determined, and the question arises: What form of pleurisy may occur without fluid which would cause such marked change? It is now impossible to say that there is a definite fan in the left apex. The lesion in the second interspace trunks shows only an old contracted fan reaching the lateral wall, posterior axillary line. Enlarged bronchi are noted, but there is no evidence of a bronchiectatic cavity.

Roentgen Examination. Plates No. 3147, made July 29, 1922, the last set of plates made, show that the remarkable change previously noted continues to be seen on the right side. The pleura is thickened from apex to base. The right diaphragm is lower than on the previous plates. The pleura is definitely thickened between the upper and middle right lobes. Slight increased density at the right base may be due to previous compression of the lung, or to some inflammation within the lung. This density is not characteristic of tuberculosis. No apical changes are noted. On the left side, a delicate fan is noted in the apex, and another, involving the posterior branches of the first interspace trunks. These are quite characteristic of tuberculosis. The large mass of increased density, so frequently noted in the second interspace trunks, anterior branches, which previously contained a cavity, now has the appearance of a contracted fan with heavy striations of connective tissue.

Case VI. White female, aged twenty-two when first admitted, in April, 1918. Nothing unusual regarding history, which extended over a period of about eight months. Beside the usual history of cough and expectoration with loss of weight and strength, she had hemorrhages of 2 to 4 oz. in the four months preceding admission. About three months after admission, she had a series of hemorrhages, amounting in all to about 39 oz., and extending over a period of less than ten days. Physical examination and history indicate the same improvement as that shown by the *x*-ray plates. About the time the first plates were made, rales were heard throughout the left lung, and signs of cavity found. These were not as typical as would be expected from the *x*-ray plates. Sputum positive, has recently been negative. On admission, patient weighed 99 lbs.; present weight, 123 lbs.

Roentgen Examination. Plates No. 1481, made in May, 1919, show in the right side a slight clouding in the linear markings of the vertebral and first interspace trunks. The linear markings in the second interspace trunks, behind the second and third interspaces and the midlobe trunks behind the fourth and fifth interspaces are studded, suggesting bronchopneumonia. A definite fan of increased density occupies the linear markings of the vertebral trunks, upper left. A circular area of increased density, lying with its rim close to the chest wall just inside the third rib, is noted on the left side. This appears to be a cavity.

Roentgen Examination. Plates No. 1672, made a year later, show most extensive lesions still in the upper left. Definite lesions are noted in the left apex and in the second interspace trunks posteriorly just above the fifth rib. In the upper left posteriorly, there is an area of decreased density, surrounded by increased density, which might be the result of a cavity. Slight apical lesions are noted in the upper right.

Roentgen Examination. Plates No. 3138, the third set, were made in July, 1922. No evidence of abnormal density is now seen on the right side except along the vertebral and first interspace trunks. The old fans are becoming more and more contracted in both apices and in the second interspace trunks, upper left.

CONCLUSION

We regret that we have not verified Gardner's work by pathological research upon human lungs, but we feel that his statement, "Caseous tubercle can heal by resolution and finally disappear completely," is correct; and further, that such frequently occurs in man. Absorption of tuberculous exudate may change a desperate to a more favorable prognosis.

DEEP X-RAY THERAPY*

BY REGINALD MORTON, M.D.

LONDON, ENGLAND

DEEP *x*-ray therapy is primarily a question of *x*-ray dosage, since it is definitely proved that under certain well-defined conditions an abnormal cell will die after an exposure to the *x*-rays that is insufficient to destroy normal cells. Purely superficial conditions are easiest to deal with, but central lesions take longer, though not difficult to treat. Subcutaneous lesions are the most difficult of all.

1. Primary Radiation. Almost any type of radiation from a tube of not less than medium hardness will give a good result if correctly used, but if the lesion has any appreciable thickness, or is placed at an appreciable distance beneath normal skin, the whole problem is completely changed.

Whatever type of radiation is used, there is a limit of skin tolerance that must not be exceeded. For any given dose at any given depth this limit is reached sooner when the tube is softer (longer wave-length radiation is easily absorbed). To increase the depth-dose we require "hard" (short wave-length) tubes, with a suitable filter to absorb all the longer wave-lengths, and a resultant beam of radiation that for all practical purposes is homogeneous. If the beam is not homogeneous, not only is the discrepancy between the deep and superficial doses undesirably large, but it is almost impossible to estimate the dose at any given depth with even approximate accuracy. Without an exact calculation, the dosage cannot be other than haphazard—pure guess-work.

Again, if we alter the wave-length with which we are working, not only is it necessary to alter the absorption factor of the filter, so as to get homogeneous rays, but we also alter the percentages of the skin dose delivered at any given depth. Consequently, if we desire to administer doses of *x*-rays to any lesion with sufficient accuracy, we must use homogeneous rays, all the factors concerning which have been fully worked out, and we must stick to that particular type of radiation.

So much for the primary radiation from the *x*-ray tube, which is quite different from that which gives the best results in diagnosis; and probably few things have done more to delay the advance of *x*-ray therapeutics than the demand for equipment adaptable for both purposes. The conditions are quite different and cannot be met in one apparatus without detriment to one or the other, or to both!

2. Secondary Radiation, Including Scattered Primary Rays. This radiation set up by the primary ray on whatever it falls, is a nuisance in diagnosis, but an important ally in therapeutics. It is difficult to measure with any accuracy, but we know that at any given depth it increases directly (*a*) with hardness of the tube, and (*b*) with the size of the field irradiated, within limits.

The increase accompanying the more penetrating type of radiation may be due to the larger percentage arriving at any given depth, or it may be that the shorter wave-lengths more readily excite secondary radiation; possibly a combination of both. These matters may be left to the physicist, but it has been found that while the secondary radiation increases rather rapidly as we increase the hardness of the tube up to a point where a voltage of about 200,000 is necessary to keep the tube in action, this increase no longer keeps the same relation to the voltage as this point is passed, and we add much to the problem of heat-dissipation without sufficient gain in other ways. I refer particularly to "gas" tubes. It is possible that with special Coolidge tubes and voltages of 500,000 or more, conditions will be sensibly improved.

The increased irradiation of any point that follows an enlargement of the irradiated field surrounding it, will continue so long as some part of the secondary radiation at the periphery can overcome the loss by dispersion and absorption on its way to the center. No advantage can follow an enlargement of the field of irradiation beyond this point.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

It is here that the splendid charts by Dessauer come to our aid. With them we can so modify our technique as to get even irradiation of any lesion of reasonable size at any depth usually found in medical work.

These charts are an inestimable boon to the radiotherapist. The broad principle taught by them is the importance of the secondary radiation and how by proper adjustment of the size of the field irradiated we gain an almost complete control over our dosage.

With this brief sketch of the physical conditions underlying *x*-ray therapy, let us now consider the biological aspects of the problem. Here I would like to pay a most generous tribute to the magnificent work done at Erlangen by Professors Seitz and Wintz, and their able staff of assistants. They have evolved what may justly be described as the first complete system of *x*-ray therapy having a sound physical and biological basis. It is not the last word on this subject, nor has it ever been claimed to be the long-sought "cure for cancer," by anyone competent to speak with authority. Nevertheless, it is the first real step towards that end, and in all probability will eventually lead to the discovery of some technique that may be regarded as a cure, within certain limits. Indeed, there are signs even now that we are not so very far away from that.

While it has been well known for a long time that living tissues undergo certain changes after exposure to the *x*-rays and that some kinds are more sensitive than others, it is only in recent years that our knowledge has attained some degree of precision. The changes seem to be primarily in the nucleus, in the matter of chromatin. The nucleus is the most highly organized part of a cell, and chromatin is radio-sensitive. The nucleus disintegrates, the cell vacuolates, and finally breaks down and is carried away by the lymphatics. But the changes are brought about more readily in abnormal cells: the more embryonic the type the more susceptible is it to radiation. The most susceptible period in the life-history of any cell is when it is undergoing division.

At present we require some unit of dosage, and the one that seems to be most firmly established is the Unit Skin Dose of Seitz and Wintz. Working under their prescribed conditions, which are easily reproducible with the equipment that they have evolved, this dose gives rise, after about five days, to a slight hyperemia which gradually subsides, leaving the skin undamaged though pigmented or "tanned." Taking this U.S.D. as 100 per cent, the limit of tolerance is as follows:

Muscle 180 per cent.
Intestine 135 per cent.
Ovary 35 per cent; temporary, 28 per cent.
Tuberculosis 50 per cent.
Sarcoma 60 to 70 per cent.
Carcinoma 90 to 120 per cent. Forty per cent stimulates; 60 to 90 per cent paralyzes.

Non-malignant growths, such as adenoma of the prostate, require a full U.S.D. because the cells are nearly normal and less embryonic.

Of malignant growths, the carcinomatous type is the most resistant, and the hard, slowly growing, scirrhous type is more resistant than the soft encephaloid. A 90 per cent dose may do for the latter; the former requires 110 or even 120 per cent.

While sarcomatous growths respond more easily, this advantage is more than neutralized by the proneness of the type to early dissemination. It is probable that this process has already begun in the great majority of cases before they come under treatment.

With regard to cases of localized, nonseptic tuberculous lesions, such as cervical glands, bones and joints in young subjects, I believe there is a large field of usefulness here for intensive *x*-ray treatment, and I understand some very excellent results have been obtained. I have not given any myself.

Measurement is carried out by means of the iontoquantimeter, or it can be done with Kienboeck's Strips. Dosage is controlled by time alone, once the activity of the tube has been ascertained. Tubes should be recalibrated after each twenty hours of use.

Coming to more practical details, let us first consider those conditions that make for success:

1. General health practically unimpaired; normal red count. Never irradiate if reds are below 4 millions; or if there is marked anemia or cachexia. A full irradiation may cause a fall of 20 per cent with an average of about 10 per cent.

We must keep in mind the fact that there is neither miracle nor mystery in this procedure. The most that irradiation can do is to turn the scale in favor of the patient, or, to put it another way, to help Nature to help herself. The cure has to be done by the patient's own vital processes, and these cannot work efficiently in the absence of a rich blood supply.

2. The lesion must be localized to a reasonably small area, with no wide local extensions. No treatment can be of any avail in saving the life of the patient, once general dissemination has begun.

3. Every part of the growth must be accurately, evenly, and thoroughly irradiated; the *x*-ray technique must be perfect.

4. The general health must be carefully looked after during the subsequent weeks.

If all these conditions are present in any given case, it may be laid down, at least as a broad principle, that the abnormal growth will disappear. This is essentially as stated by Wintz, and though I rarely get cases under these favorable conditions, my experience enables me to accept it.

There is an important point that must not be overlooked. A large number of the cases that come to us are recurrences after surgical operation. These are not so favorable for us. Successful irradiation depends on a normal vital reaction, increased blood supply, leucocytosis, phagocytosis, etc., with free blood and lymph circulations. This is impossible in an area that has been the site of a more or less extensive surgical procedure. Circulations are but partly restored, and vital reactions are inefficient.

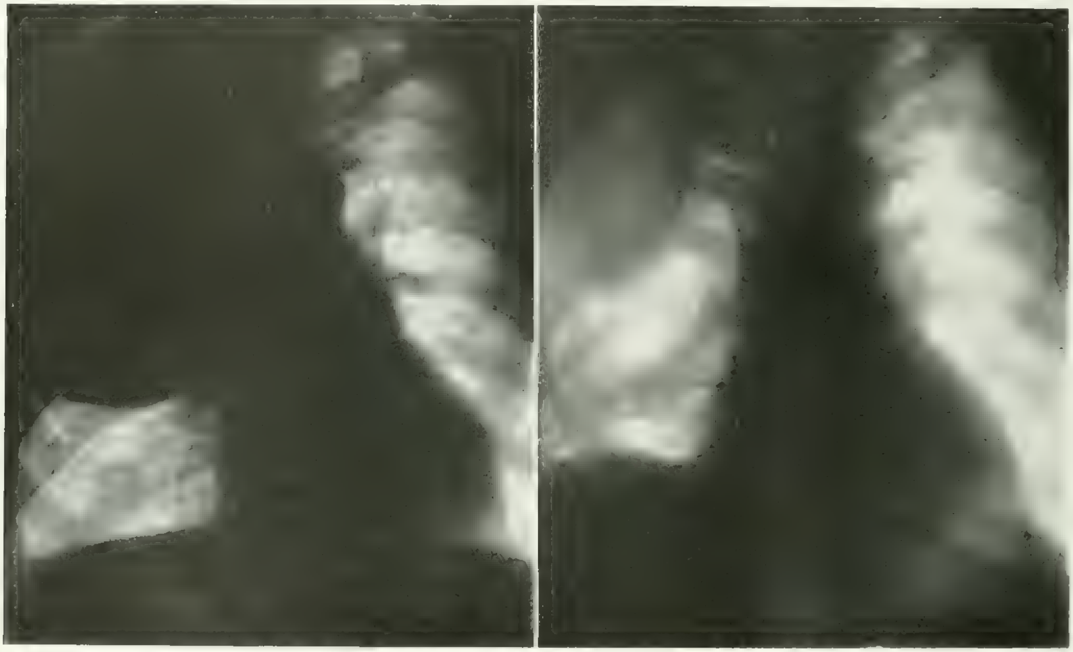
TECHNIQUE

In practical work we are bound by certain limitations. No skin area or other normal structure, as far as possible, is to receive more than the U.S.D. Not that a moderate overdose would, in itself, constitute a grave injury; the sharp local reaction following such is far removed from the *x*-ray burn of former days, when filters were inadequate (if we used any at all) to stop all the softer rays.

Overdoses, and also normal doses if repeated three or four times, bring about an obstinate local edema that is as undesirable as it is unique. These hard rays seem to have a special action on the local lymphatic circulation; it is particularly noticeable when treating lesions of the neck and maxillary regions. I have frequently seen a well-marked local edema come on during a first irradiation. It is not painful, and usually subsides after some hours, but for the time the outline of the face is quite altered. Occasionally, it is so slight that it may escape notice. If noticeable on a first irradiation it will be more noticeable on subsequent ones—progressively. The edema of over-irradiated skin gives the patient a feeling of "tightness;" the skin is not painful or seriously discolored, but is smooth, hairless, and of a firm boggy texture that pits readily on pressure, and can be pushed up into ridges which take some time to disappear.

There is no doubt that the local lymphatic circulation has been profoundly, and probably permanently, altered, and I feel sure it is a condition we should try to avoid, since we depend so much on efficient local circulation for our results. Overdosing is inadmissible at all times and in all places.

The next difficulty is the loss of radiation, between the surface and the lesion beneath, by (*a*) dispersion, and (*b*) absorption. These are known, are constant and easily ascertainable, and need not detain us for the present. I would, though, remind you of the percentages in a typical case at the different levels below the skin, taking the dose on this as 100 per cent. They are at centimeter intervals—80, 65, 55, 46, 39, 34, 30, 26, 23, 20 (these approximate whole numbers, fractions being ignored). The point to be remembered is that as we get further down, the radiation tends to become more uniform. So far as experiments have gone up to the present, the depth percentages are not relatively increased by the use of higher voltages and harder tubes than those normally used at Erlangen. Recent modifications have made it possible to reduce the time of exposure by approximately 30 per cent, but the depth percentages remain sensibly unaltered. Loss by dispersion can never be altered, and the factors of absorption and secondary radiation are not sensibly affected by moderate increase of voltage. Possibly an equipment designed to work successfully at 500,000 volts may so reduce exposures and increase depth percentages that we can treat two patients in the time we now take to treat one.



January 19, 1922. August 11, 1922.

This would be a decided practical advantage, and it is not improbable that the blood would suffer less by virtue of the shorter time. For the present I think it better to continue on the lines laid down at Erlangen, if only for the high degree of accuracy in dosage it gives us. It is being steadily improved in details, and even now gives some splendid results when accurately carried out in suitable cases and under favorable conditions.

There is another point I would like to raise. Speed is the great desideratum in most of our services; are we quite sure of the wisdom of pushing this to the limit when we are dealing with living tissues? It would be very nice if we could snap-shot our cases in the way we take our holiday photographs, but there is a difference, and I feel that within limits a certain length of time is advisable and necessary. Living cells are far removed from photographic films; there is all the difference between *vitro* and *vivo*.

As I stated in the beginning of this paper, superficial conditions are easy to deal with. If the skin only is involved we can obtain a very even irradiation by a long focal-skin distance, increasing the time as the square of the distance. The slight loss by dispersion and absorption is partly made up by the secondary radiation from the tissues beneath; up to a point the same applies to lesions less than about $2\frac{1}{2}$ cm. from the surface, but even accurate dosage is difficult and the results are inferior.

Central lesions are probably the easiest to treat with accuracy. Having ascertained our depths, and knowing the percentages from each port of entry, we attack the lesion from as many points as are necessary to build up the desired dose; by using one or two extra ports of entry we can proportionately reduce the time for each, giving less than the full skin dose. No skin reaction follows, and the same areas may be used again without risk of permanent injury, such as the edema to which I have referred. So long as we know the activity of the tube with which we are working, the site and extent of the lesion, and have an accurate knowledge of topographical anatomy, the treatment of central lesions is a perfectly straightforward matter.

As I have already stated, the difficult cases are those semi-superficial ones where we are limited practically to one port of entry, and particularly when the lesion is situated in those parts of the body having an irregular contour, such as the jaws, neck, female breast, vulva, and anus. In addition to the difficulties due to locality, lesions involving or communicating with the various apertures have the further complication of sepsis, and a very formidable one it is.

For a long time, the general method of treating these lesions was that of "distant radiation," where the anticathode was placed at any distance up to 100 cm. from the surface, the time of exposure extending from six to ten or twelve hours.

Placing the tube far away helps us in two ways. It not only lessens the influence of contour irregularities, but also makes the depth percentages more favorable and more uniform. This is all to the good, and while some excellent results have been obtained, there is much room for improvement.

We have seen that it is more easy accurately to irradiate central lesions; also that the deeper down we go, the more uniform is the irradiation. If we could temporarily convert our superficial or semi-superficial lesion into a central one, from a radiological point of view, many of our difficulties would vanish. Fortunately, this is not beyond us. Supposing the lesion is 1 cm. below the surface, and that we place between the applicator and the surface a block 10 cm. thick of some material having the same absorption and secondary radiation value as normal tissues. Several substances answer to these requirements; water is one, though perhaps not the most convenient to use; paraffin wax, beeswax, and dough made from ordinary flour are all suitable. Casman of Antwerp makes first a sort of shell mold of the part with softened paraffin wax. This we may call the *negative*. From this an assistant makes a positive in plaster of Paris. From the latter he makes the final negative, casting it in two halves in a proper molding box. When the patient comes for treatment the part is enclosed in this mold and treated as for a central lesion. In this way he gets a wonderfully even irradiation of these superficial lesions and more satisfactory results.

Many cases can be treated on this principle without the trouble of making the mold. Returning to the lesion I have just instanced, with 10 cm. of wax between the skin and the applicator, we know the percentage we get at this depth, say 20 per cent. Therefore, we can expose five times as long before we get the U. S. D. at the skin surface, and we will find that we have got over 90 per cent at 1 cm. below the surface instead of just under 80 per cent when the applicator was in contact with the skin. This is nearly as much as we want, and an application from the opposite side or other convenient angle soon completes the dose. In practice, we use as many ports of entry as convenient and equalize the portions of the dose among them.

A set of wax blocks of various sizes and thickness are invaluable and will obviate the necessity for elaborate molds. For very irregular surfaces the inequalities can be first leveled up with a dough made of flour and starch paste. The latter gives it a firmness, pliability, and freedom from stickiness that is very desirable. Wax blocks are then piled up to such depth as is desired.

Here is a field for exercise of some ingenuity; we want some ever-ready, convenient means of enclosing these lesions in a medium that complies with our requirements. What about water-containers with sides or ends made of thin rubber so as to be easily adaptable to surface irregularities? Again, why not some material like "Plasticine" that could be molded at will?

Plasticine in its present form is not suitable, owing to its very high absorption, due to the presence of materials of high atomic weight. Perhaps the makers of this material could provide a special mixture answering our requirements; one that would be easy to mold, clean to handle, and yet sufficiently firm to retain its shape at normal body temperature. This subject is worthy of attention, and I hope something will be done without long delay.

Before I close, there is a question I would like to ask. As is well known from past experience, repeated fractional doses of *x*-rays have an inhibitory influence on cancer cells, but if we increase either the individual doses or the frequency of their administration, so that the cumulative effect reaches a certain point, such cells are stimulated to active proliferation, and may bring about a visible increase of the tumor within twenty-four hours. Are there not certain circumstances where we might turn this property to good account? Some cancerous growths are very resistant to radiation—probably because they are made up of a more fixed type of cell. We know that cells are more vulnerable while undergoing division; why not give such a growth a stimulating dose first so as to bring on proliferation? Then, as soon as this is established, irradiate again right out to the full lethal dose. Naturally, the scheme is applicable to a limited number of cases, but I am rather attracted to it. Some may consider it too risky, but after all, what are the circumstances?

Is it not the case that the patient with malignant disease is fairly "up against it" for his very life? Is it not also the case that, with deplorably few exceptions, the patient with malignant disease dies of that disease? So long as we have knowledge and experience of what we are doing, are we not justified in taking these risks on behalf of our patient? I think this point is one worthy of discussion.

One more detail before I close. There is a tendency among medical men generally, from which radiologists themselves are not altogether free, to attach too great importance to the apparatus, and too little to the man in charge of it. We do not estimate the capabilities of a surgeon by the keenness of his cutting edges, or even by the extent of his surgical armamentarium. I have seen a lady walking about Edinburgh, with a scarcely perceptible limp, whose astragalus was excised, in an emergency, by a famous surgeon personally known to myself, with no other tools than his pocket-knife and a screw-driver! The operation was a brilliant success from every point of view.

What I want to emphasize is this, particularly as regards *x*-ray therapy. The roentgenologist who knows his subject, and the capabilities and limitations of his equipment, will always get a higher percentage of favorable results than his intellectually inferior colleague with the most elaborate apparatus available.

In conclusion, and by way of encouragement, I shall relate to you briefly the essential details of 2 or 3 cases I have treated. In the early part of this year a leading London surgeon asked me to see a lady with a cancer of the right breast; one of those diffuse, discolored, rather rapidly growing tumors, with enlargement of the axillary and infraclavicular glands. He considered it quite unfavorable for operation. The question was, could I so far improve the local conditions as to make surgical intervention feasible? Six weeks afterwards, glandular enlargements had almost completely vanished (only one irradiation) the tumor itself had disappeared, had lost all its malignant characteristics and the breast itself was almost normal, except for the deformity brought about by the shrinkage of the growth. The patient is now wonderfully well and the question of surgical operation has been shelved indefinitely.

In March, 1921, a man of forty-two, in a very weak and emaciated state, was admitted to St. Bartholomew's Hospital suffering from cancer of the esophagus; the obstruction was practically complete and a gastrostomy was done to obviate death from starvation. He had lost over 50 lbs. in the previous five months. A little over a year ago I gave him *x*-ray treatment at the West London Hospital. Within three weeks, food began to pass through the obstruction, and a day or two later, he used the gastrostomy opening for the last time. He has had two irradiations since; he is now back to his normal weight, and when it comes to putting away a square meal, he can keep his end up with the best of them.

On St. Patrick's day of last year, I treated a gentleman who, a few weeks before, had been opened up for obscure abdominal symptoms. He was sixty-seven, with a cachectic appearance, though there had been only a moderate loss of weight. A typical carcinoma of the pancreas was found, the opening was closed, and nothing was done. He was rather upset by the treatment and was in a feeble condition for about three weeks afterwards. He began to take food more freely, and steadily to improve in every way. At the end of July he was going about as usual, traveling frequently between London and Paris without undue fatigue, and for the past twelve months he has not had a single unfavorable symptom.

In July, 1921, a gentleman was brought to me with what had been definitely diagnosed by a leading urologist as malignant prostate. He had arrived at the catheter stage, was slowly losing weight, and was just beginning to show signs of a commencing cachexia. He had only one irradiation. The catheter was put away five weeks later; he is now quite well and enjoying life.

In January, 1922, a gentleman was examined roentgenographically for dyspnea, among other symptoms, and was found to have a large growth in the upper right thorax, obliterating the upper lobe and bulging down over the middle lobe in front. The diagnosis was a sarcoma, possibly an encysted hydatid, and the case was regarded for all practical purposes as hopeless. In February, I was approached on the question of *x*-ray treatment, but owing to his weak, emaciated condition and the general seriousness of the case, I had no hesitation in declining to treat the case. I felt that the immediate effect would probably kill him.

He and his immediate relatives were quite alive to the seriousness of the situation as well as to the reasons I gave for advising against *x*-ray treatment. Two or three days later I was approached again with an urgent request to take the case in hand. The patient and his friends took the view that if I were correct, the worst that could happen would be an anticipation of what seemed the inevitable end, and if this did happen he would prefer it to lingering on; on the other hand, being a man with a clean medical history, who had always been in excellent health, he felt that he had a chance, and was ready to take all risks if I would consent to let him have "a run for his money." There was, of course, no alternative. He came on a stretcher by ambulance, and it was with no small sense of relief that I saw him back into the ambulance still alive, after the treatment was over, which I carried through thoroughly and completely. I saw him a few days before I left London. Considering the poverty-stricken condition of the Harley St. neighborhood, I chided him for lack of consideration in bringing such a picture of rude, rugged health into the district! For the first few days he felt rather more than usually prostrated, but this passed off. About ten days later the dyspnea began to subside and steady general improvement set in, continuing for several weeks. A second irradiation was given in May, as he seemed to have arrived at a stationary condition. Again rapid improvement set in and continued up to the time I last saw him—the day the second plate was taken, and a third irradiation given to shrink up further the mass that still remained. At present he looks in perfect health, and goes about briskly like any ordinary man of his age—forty-three. He still refrains from his favorite game, lawn-tennis, more out of respect for his medical advisers than from his own inclinations, but quite thinks he will have a game before the summer is gone.

AN UNUSUAL CASE OF DOUBLE SPONTANEOUS PNEUMOTHORAX*

BY CHAS. P. EMERSON, M.D., AND RAYMOND C. BEELER, M.D.

From The Robert W. Long Hospital, Indiana University School of Medicine

INDIANAPOLIS, INDIANA

FEMALE, No. 10314; unmarried; twenty-two years old; admitted to the Robert W. Long Hospital, September 21, 1920; discharged, January 8, 1921; readmitted, No. 11039, February 10, 1921; died, April 22, 1921.

Complaint. Asthma.

Family History. The patient's mother, aged forty-four, is living, but not well, for she has sick-headaches frequently and gets tired and "feels badly" as the result of ordinary household duties. Her father has undergone seventeen operations for a recurring growth in his nose, for which recently he has received radium treatment. The patient is the oldest of five children, two brothers and two sisters, all of whom are living and well, and none of whom have had asthma.

It is interesting that her father's grandmother, both of her mother's parents, two of her mother's seven brothers and one of her mother's three sisters all suffered from asthma.

Past History. When the patient was six months old she fell from her high-chair and "was unconscious for some time." She had "catarrhal fever" at the age of one year, whooping-cough with good recovery at four and measles at six. She never has had pneumonia. She has, since childhood, had frequent attacks of tonsillitis.

She had her first attack of asthma, which followed the exertion of walking to visit a neighbor, when she was two and a half years old. After that, the least exertion or a simple coryza would bring one on. Until she was eleven years old these attacks were much worse in the winter than in the summer, and were precipitated especially by exposure to cold air; but during the past ten years they have been worst during the months of June, July, August and September, during which months she suffers from one continuous attack of asthma which nothing seems to relieve, and on account of which she loses considerable weight. In the winter, the attacks are much less frequent and are more easily controlled. Until the last three years, the asthma has been accompanied by paroxysms of severe coughing which terminated with the expectoration of large quantities of sputum, sometimes "even a quart." Until the last few weeks, because of the dyspnea, she has, during an attack of asthma, never been able to lie on her right side. During the long, severe, summer attacks she has no appetite, suffers much from gas on the stomach and often, several hours after eating, vomits undigested food. She sometimes can relieve the asthma by inducing emesis. She has been so habitually constipated all her life that frequently the bowels have not moved for a week at a time, and yet, until the past two years, she has seldom used cathartics. The straining at stool has often made an asthmatic attack worse but has never precipitated one.

During an asthmatic attack, and also as the result of exercise during the asthma-free periods, she has complained of palpitation of the heart. Her lower extremities frequently have been edematous.

With the attacks of dyspnea the patient has always had "asthmatic" headaches, a severe throbbing in the temples, and also other headaches which glasses have relieved. She recently has had a continuous supraorbital pain. She has had frequent attacks of vertigo.

During the asthmatic attacks she has suffered from pollakiuria and polyuria.

The patient has never been able to do much work or to take exercise. She attended the common schools for seven years and high school for one semester.

Present Illness. Her asthma has been much worse this winter than last; nevertheless it is much better than it was last summer. She has recently not noticed any difference in her breathing capacity. She must lie in bed propped up, formerly leaning only on the left side, but during the past few weeks has been able to lean towards the right side also. She has gained about 18 pounds since last autumn, and now weighs 87 pounds.

---

* Read at the Midwinter Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, Ill., February 22, 1922.

Physical Examination. Her frame is slender, her musculature undeveloped and her nutritional condition poor. The skin has a yellowish pallor, but is not jaundiced, is inelastic and somewhat dry. The facial expression is intelligent and keen, but shows every evidence of intense suffering.

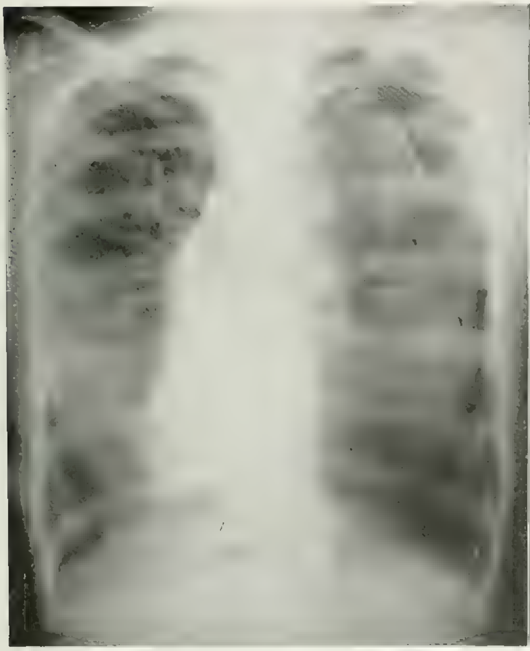


Fig. 1. Sept. 30, 1920. Single film of the chest shows the contour to be barrel-shaped. The heart is small and hanging, the mediastinum slightly widened. There is exaggeration of the hila and of the linear markings throughout both lungs. On the right is a partial collapse of the lung, with a pneumothorax. This is especially marked in the upper third of chest.

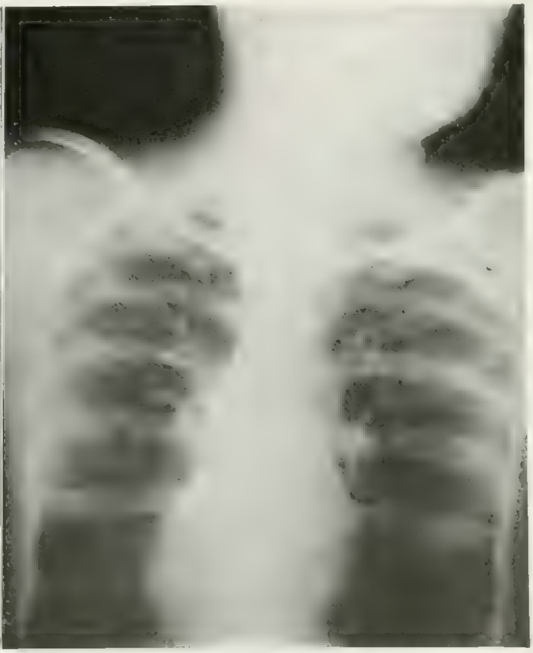


Fig. 2. Sept. 30, 1920. Stereo plates show same condition as flat film. The pneumothorax is clearly outlined. There are some signs of adhesions because of inability of certain parts to collapse. The apices on both sides show considerable exaggeration of the linear markings. The diaphragms are somewhat fuzzy in outline, due to pleuritis. Costophrenic angles are slightly obliterated. The mediastinum and heart are displaced to the left. Both lungs show emphysema.

The eyes are normal; the pupils react to light and accommodation. The nasal septum is deflected to the left side, where it presses against the middle turbinate bone. The nasal mucosa has a grayish color and crusts which indicate an atrophic rhinitis. The tonsils, while not very large, are definitely infected.

The tongue is covered by a moist white coating. There is pyorrhea around several teeth, especially the two lower incisors.

There is no enlargement of the thyroid.

The thorax is definitely barrel-shaped, and therefore appears relatively large for the patient. It expands very little on inspiration. There is a marked kyphosis of the upper thoracic spine, winged scapulae and sternum and ensiform so prominent that the patient is definitely "pigeon-breasted."

During the first of her stay in the ward she spent most of the time sitting up in bed leaning forward. Her dyspnea was distressing; all the accessory muscles of respiration were in use. The physical signs were those of a marked emphysematous chest during an attack of paroxysmal asthma; that is, the chest was definitely hyperresonant on percussion, the breath sounds loud, with tubular modification, and accompanied by sonorous and whistling rales.

The point of maximum impulse was diffuse, located about 4 cm. from the midsternal line at the level of the fifth rib. There was some epigastric pulsation. The apex beat could not be distinctly palpated, but an impulse was felt $4\frac{1}{2}$ cm. from the midsternal line in the fifth interspace. The right cardiac border could not be well defined. There was some retrosternal dulness. The heart sounds were distant, but clear, with the accentuation on the pulmonic second.

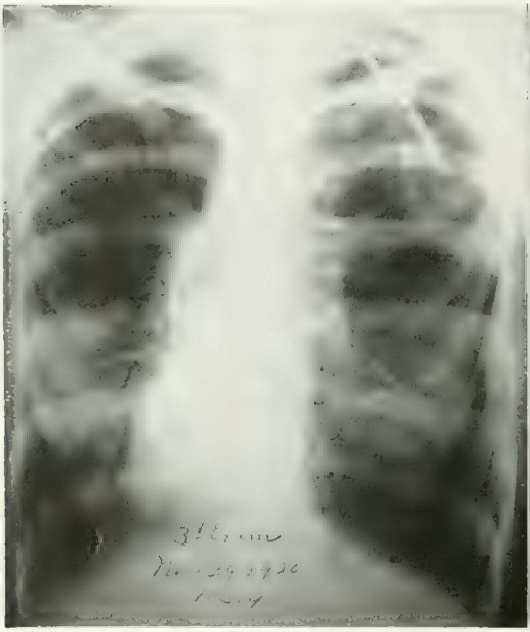


FIG. 3. Nov. 29, 1920. Stereoscopic plates show an increase in size of the right pneumothorax. The lung is collapsed from the first to the fifth rib.

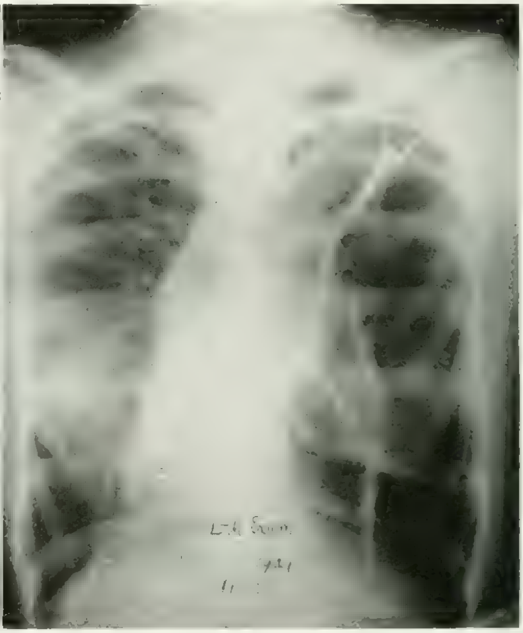


FIG. 4. Feb. 14, 1921. Stereoscopic plates of the chest show almost complete collapse of right lung with exception of some adhesions in apex and posterior lower lobe.

The upper limit of deep hepatic dulness is about an inch above the costal border in the right mammary line. The lower border of the liver reached the level of the umbilicus in the midline.

There was no general glandular enlargement.

During her stay in the hospital this patient might for weeks be quite free from asthma. She then could walk around the ward with comfort, was quite free from cough and could lie with her head low, although she preferred the back of the bed always to be raised. She was, during these periods, a typical case of extreme pulmonary emphysema. During damp periods, and especially at night, she would, for several days at a time, have frequent attacks of typical paroxysmal asthma with very sudden onset, which lasted from ten to twenty-five minutes. The night-nurse, sitting at her table in the ward corridor, could hear the asthmatic breathing as it began, and would hurry to give her an hypodermic injection of 5 minims of adrenalin. This was repeated often three or four times a night. During these attacks her appearance was pathetic; crouched forward on the bed, blue from cyanosis, struggling for breath, unable to speak or even to stir. Then, for a few days, she might not have one attack.

October 10, 1920: No reaction followed the hypodermic injection of $^{1}/_{200}$ mg. of old tuberculin.

October 19, 1920: The patient was vaccinated with milk, egg, and tuberculin in the order named. All were negative.

October 29, 1920: The patient had a very severe attack of dyspnea last evening which lasted two hours or more.

November 12, 1920: The patient's tonsils were removed. They proved to be quite infected. The improvement in the respiratory symptoms which followed this operation, and which lasted for several days, was surprising, and high hopes were entertained that a subsequent necessary operation on her nose might bring still greater relief.

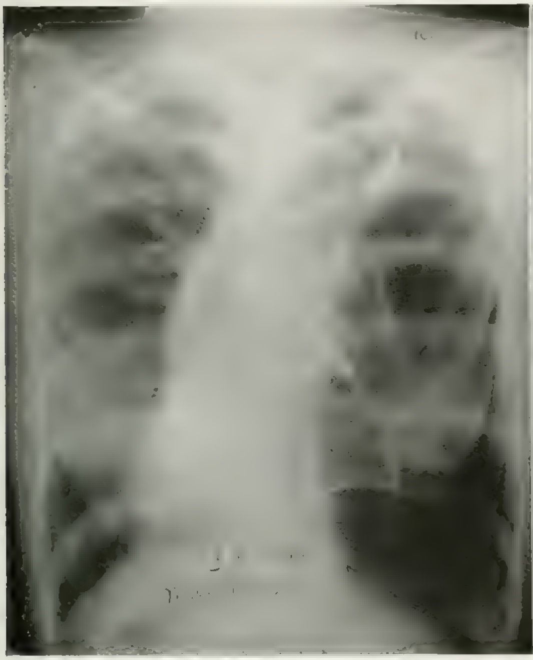


Fig. 5. Mar. 12, 1921. Stereoscopic plates of chest show a slight change in the right chest, the lung having expanded slightly in the region of the sixth and seventh interspaces. The upper and anterior chest walls show a peculiar elongated dark shadow which appears as a tear in the parietal pleura. There are adhesions around it. Interpretation of this seems difficult. The left border of the mediastinum shows some increase of air, there being a dark shadow that seems to cap the heart.

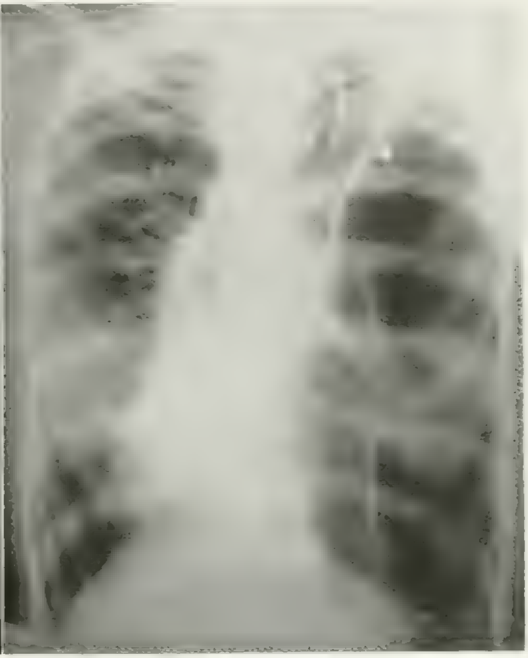


Fig. 6. Stereoscopic plates of the chest show about the same condition of right chest, with possibly slight increase in fibrosis. The area described in last examination as a tear of parietal pleura located in upper anterior chest has increased in size until now it covers an area of considerable size.

November 24, 1920: The patient was vaccinated with the proteins of egg, wheat, and horse-dandruff. Two controls were made in each case, each 1½ in. on both sides of the original vaccination. Neither the egg nor the wheat gave any reaction, but the horse-dandruff gave a distinct reaction, a wheal 1½ in. in diameter rising around the original point of vaccination.

No reaction followed the subdermic injection of an autogenous vaccine prepared from the bronchial sputum.

She reacted positively to rabbit hair, Staphylococcus pyogenes aureus (slight reaction), Staphylococcus pyogenes citrus (slight), salmon and tomato; but negative to goose-feather, Staphylococcus pyogenes albus, rice, rye, squash and sweet potato.

The patient says that she has handled rabbits and does not believe they aggravate her condition, while goose-feathers have caused violent paroxysms of asthma. She was sure that tomato soup has on many occasions benefited her.

December 14, 1920: The tests were slightly positive for the proteids of wheat, oyster, peanut, pork and casein; distinctly positive for cat-hair (3 plus), cattle-hair (3 plus), potato (?), Brazil nut, carrot (?) and cheese (?); but negative for turkey, veal, English walnut, pea, bluefish and buckwheat.

December 17, 1920: The protein tests for lentil, lamb, lima bean, lobster, mackeral, mustard, corn, crab, eggplant, egg white, egg yolk and lactalbumin all were negative.

November 24, 1920: A right-sided partial pneumothorax was unexpectedly discovered by means of roentgenograms. These plates had been taken as a matter of routine. In tracing back her history, no clue could be obtained as to the date of origin of this condition. Indeed, it may have been present for a long time. This discovery led to several much more careful examinations of the chest. It was thought possible that the right side did lag a little in the movements of respiration, and that the interspaces on the right side were more noticeably obliterated than on the left side. Litten's sign was absent on both sides. Fremitus was felt over both apices posteriorly, perhaps a little more distinctly on the right than on the left side. Both sides were hyperresonant on percussion, but the note over the right side may have been a little more tympanitic than that over the left. The lower posterior limits of pulmonary resonant were at about the same level. The breath sounds in general were loud and blowing with expiration much prolonged and accompanied by whistling rales heard over the entire chest during both inspiration and expiration. They were unusually loud over the left apex, over which area expiration was much prolonged. Whistling and musical rales were heard over the left lung. The breath sounds were perhaps more distant over the right lung and had an amphoric quality. The whispered and spoken voice were well heard over the base of the right lung, but were distant over the left lung. The coin sound was a little more distinctly heard over the right lung at the base and in the axilla than over the corresponding area of the left chest, but this was by no means definite and the typical coin sound certainly was absent. No splashing could be heard on succussion. We would emphasize, however, that these signs of pneumothorax were not at all definite, and that the examinations were made with the full knowledge of what the plates showed.

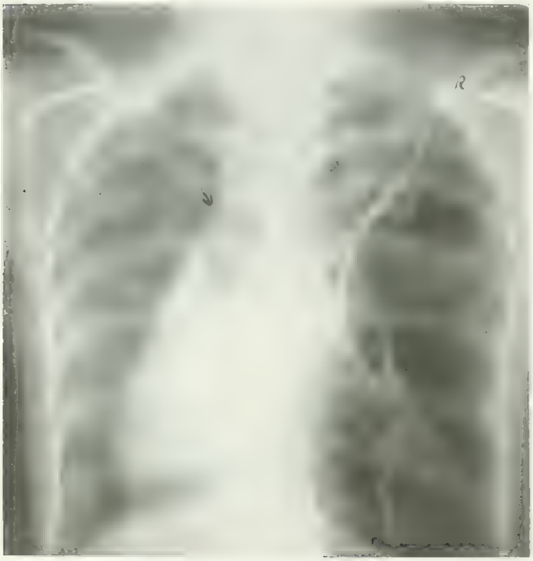


Fig. 7. Apr. 23, 1921. Stereoscopic films of chest, postmortem, show the same extensive pneumothorax and adhesions on the right, with the heart and mediastinum displaced to the left. There is a slight suspicion of an area of pneumothorax in the posterior part of the left upper lobe. The main bronchus on the left seems extremely dilated and prominent, with very prominent trunk areas. The lung on the left contains so much air that it has the same appearance as the opposite chest. There is the appearance of a double pneumothorax.

The urine on all occasions was quite normal, containing no albumin, no sugar and no casts. The red blood count was 6,000,000 and the hemoglobin 90 per cent. The leucocyte count, on September 28th, was 9,000 per c. mm., of which 12.4 per cent were eosinophiles. In another count, later, 14.6 per cent of the leucocytes were eosinophiles. The temperature frequently rose to 99° to 100° F. in the afternoon; the pulse varied from 80 to 128, and the respirations were about 24 per minute.

The patient, feeling better, went to her home on January 8, 1921, but soon returned in great respiratory distress.

Second admission, Feb. 10, 1921.

March 19, 1921: "The patient at 6:30 this morning had a very severe attack of asthma. Four minims of adrenalin hypodermically relieved her for about half an hour. Then followed a second attack of dyspnea which lasted about fifteen or twenty minutes. She is more comfortable when well propped up on a back rest, her bed in front of an open window."

March 21, 1921: "The patient's dyspnea is not quite as marked. Her respirations are 24 per minute."

April 8, 1921: "Patient seems much better; her respirations seem much easier than usual."

April 18, 1921: "The patient is not doing well. Her attacks of dyspnea are more frequent and more severe, especially during damp weather."

Fractional gastric analysis showed on one occasion (February 25, 1921) no free hydrochloric acid and a low total acidity which varied from 14 to 33 acidity per cent. Another examination, on March 5th, gave a total acidity of 68 and free hydrochloric acid of 25 acidity per cent.

The sputum, frequently examined, contained no elastic tissue and no tubercle bacilli.

The urine was always normal, its specific gravity varying from 1.010 to 1.022, and it always was free from albumin and sugar.

Between February 10 and March 17, 1921, the temperature ranged between normal limits, the pulse between 86 and 122, and the respirations about 24 per minute.

One blood-count during this admission was: Red cells, 5,448,000; leucocytes, 8,600, of which 79.5 per cent are polymorphonuclear finely granulars, 7 per cent small mononuclears, 1.8 per cent large mononuclears and 11.6 per cent eosinophiles.

April 22, 1921. Final note. "The patient has been losing ground for eight or nine days; the dyspnea has been almost constant and attacks with cyanosis have been frequent. This evening, while on the bedpan, she experienced a sudden increase of the dyspnea with cyanosis, and died in fifteen or twenty minutes."

Autopsy. Anatomical Diagnosis. Bilateral pneumothorax, complete collapse of right lung, partial collapse of left; bilateral fibrous pleuritis; moderate thickening of bronchial mucosa in the larger bronchi; generalized passive congestion; healed mitral endocarditis; chronic appendicitis; moderate fibrous thickening of the gall-bladder with slight scarring of the adjacent liver tissue; distention of chest; visceroptosis.

The body is that of a slightly-built, adult, white woman, about 5 ft. tall and weighing about 90 lbs. There is marked cyanosis of the finger-tips and head back of the ears and neck. The superficial lymph-nodes are not palpable. The chest is expanded and barrel-shaped. Subcutaneous fat is scanty. The skeletal muscles are normal in color. Peritoneal surfaces are markedly congested and of a purplish color. The liver margin reaches about 10 cm. below the xiphoid cartilage in the midline and on the right side below the level of the iliac crest. The diaphragm is low, at the sixth interspace on the right and at the seventh on the left side.

There is an escape of free air on opening the right pleural cavity which was demonstrated by the water test. The same is true of the left pleural cavity.

There is no free fluid in the peritoneal cavity. There is marked congestion in the region of the appendix, which is bound down retrocecally. There are no adhesions in the peritoneal cavity.

The right lung is totally collapsed. It is adherent to the chest wall about its apex and anteriorly and posteriorly over its lower lobe.

The left pleural cavity shows many adhesions. The anterior margin of the left lung is markedly distended and emphysematous. The lower lobe of this left lung is partially collapsed; its posterior portion is deeply congested, purplish red in color and contains but very little air. On section it shows a glassy appearance, is uniformly congested, but contains no free fluid. The mucosa of the bronchi is congested and in areas appears thickened.

The right lung contains no air, is of a deep, purplish red color, is markedly congested and resembles spleen in consistency and color. A fragment barely floats in water. There is moderate congestion of the bronchi.

There is no evidence of tuberculosis in either lung.

The myocardium is rather fibrous, but shows no other visible changes.

The gall-bladder is adherent to the liver substance and to the mesocolon. Its wall is slightly thickened. It contains about 15 c.c. of bile, but no concretions.

The liver is normal in size and shows no changes on section. There are a few superficial scars in its capsule in the region of the gall-bladder.

The pancreas is deeply congested and rather soft. There is capillary extravasation of blood within the pancreatic substance.

The left kidney is rather small, weighs about 125 gm., and on section has a deep, cyanotic, red color. Its capsule strips with normal resistance. Fetal lobulations are visible over its surface. There are a few scattered subcapsular scars, but no other gross changes. The right kidney resembles closely the left.

The gastrointestinal tract shows no visible changes except marked congestion.

The uterus and appendages are markedly congested, otherwise normal. The adrenals are normal in size and appearance, with no loss of the yellow pigmentation of the cortex.

This, then, is the case of a young woman twenty-two years of age, who, since she was two and a half years of age, was practically invalidated by very frequent attacks of true paroxysmal asthma, a tendency which she apparently had inherited from both her father and her mother. This asthma led to marked chronic hypertrophic pulmonary emphysema. We have no evidence whether or not she inherited also a tendency to emphysema. One result of the latter condition was a chronic partial pneumothorax, so latent that it was not suspected until the roentgenograms of her chest were studied. Even after we knew of its presence, we could get no history which suggested the date of its onset. It certainly was present for months before her death. We feel justified in believing that her sudden death followed the sudden development of a double pneumothorax while she was straining at stool a few minutes before her death.

While well over 90 per cent of all cases of pneumothorax are due to pulmonary tuberculosis, yet we feel we can rule out the presence of that disease in this case, since during life and at the autopsy especial attention was paid to this point, and no evidence of, or lesions of, pulmonary tuberculosis could be found. We believe the double pneumothorax of this patient was due to chronic hypertrophic pulmonary emphysema. It is not at all surprising that this disease should lead to pneumothorax; the only wonder is that it does not more often do so. In chronic hypertrophic pulmonary emphysema, the disappearance of the septa between many adjacent alveoli results in the formation of large air spaces, or blebs, each the sum of many alveoli. The superficial blebs have the pleura as external wall, and the nutrition of this membrane over these blebs is certainly hazardous, since the normal pleural membrane receives its nutrition from the underlying lung tissue. The inevitable result of the disappearance of groups of underlying septa with their blood-vessels must be a progressive atrophy of the pleural membrane at these points, from lack of nutrition. This will progress until finally it becomes so weak that it can be ruptured by even an ordinary respiratory movement. Such must be the explanation of those spontaneous non-tuberculous cases of pneumothorax which develop during sleep, although more often as the result of some spasmodic effort such as laughing, coughing, sneezing, jumping from a chair, dancing, running up stairs, straining at stool, etc. In the case of those previously healthy, however, the bleb must have been the result of interstitial emphysema rather than of the chronic hypertrophic variety. One should remember that it is the pleura which protects the pleural cavity from pneumothorax, since undoubtedly the lung tissue is frequently ruptured by coughing and other strains. As the result of such rupture, the air escapes into the interstitial lung tissue, lifting the pleura into blisters torn free from the underlying lung. So difficult is it to rupture the pleura, that in cases with severe paroxysmal cough and in the strain of parturition, the air will dissect its way along the bronchi into the mediastinum and then through the suprasternal notch into the subcutaneous tissue over the chest wall, and yet none find its way into the pleural cavity. These blisters of pleura freed from the underlying lung tissue and its vessels must explain the great majority of spontaneous pneumothorax which develops in quite healthy persons, even months after the least physical strain. In cases of chronic hypertrophic emphysema such as this girl had, the *bullae* present may be even as large as a pigeon's egg.[1] The fact that the emphysematous lung had lost practically all its elasticity hindered its collapse, and therefore, until the last day, probably prevented the formation of a complete pneumothorax. The facts that the pneumothorax was partial and that the emphysema alone caused such respiratory distress explain why the condition was so latent.

---

[1] HUGHES. *Guy's Hosp. Rep.*, 1852–3, 2d s., viii, i.

While emphysema is the proven cause in relatively few cases of pneumothorax,[2] this is, so far as we can ascertain, the only case on record of double pneumothorax due to emphysema.

DISCUSSION

Dr. LeWald. We have had three cases of spontaneous pneumothorax nontuberculous. The first case occurred in a man who was taking a cold shower and collapsed. He had been examined just a few days before for life insurance. He was twenty-five years old, and his lungs at that time were perfectly normal. He made a complete recovery in about four weeks. He was put on some physiologic respiratory movements to try to expand the lung, such as blowing on the bottles. He never had any recurrence, and never had any tuberculosis develop. He was examined for a period of two years.

Another case was in a messenger boy who was running across the street and collapsed. He was taken to the hospital, where it was found that he had a spontaneous, or perhaps not quite spontaneous, pneumothorax. That lung also expanded, but it took a longer time—about six weeks.

The third case was in a younger subject, a boy of about nine years of age, in which we had no history of forcible effort. It was on the right side, pushing the heart over to the left, much as in the preceding case. He was watched for six months and the condition did not clear up. That brings up the point that was brought up in this case—how long can a pneumothorax exist before being discovered in routine examination? I think the point is that there are many cases of nontuberculous pneumothorax.

Dr. Keith. We have seen three or four cases of this kind. One case occurred in a child with diphtheria followed by exertion. The child died a few hours after the plate was made. That was an acute infection.

Another case was that of a little fellow, two and a half years of age. The clinician, who was called to see another member of the family, noticed that the little fellow was out of breath. He brought the child into the office and was unable to make a diagnosis. This child had a collapse of the lung on one side. The plate showed a very definite adhesion of the pleura at about the junction of the upper and lower lobes. We rayed him again three or four weeks after, at which time the lung had begun to expand. A plate two months after showed a complete recovery. This child had nothing except a little cold.

In the other patient, according to the history, the collapse of the lung occurred while she was mountain-climbing in Colorado twelve years before. She had a little trouble immediately after, lasting three or four days, but no trouble subsequently. At the time we saw her she had no symptoms. The plate showed the collapse still present.

Dr. Crane. Dr. Beeler, in his paper, mentioned the fact that the lung tissue may be frequently ruptured when pneumothorax is not produced. This may cause the annular shadows we see in the lungs which we are inclined to call cavities, even when there is no disease evident. If that is true, there may be some danger, when these annular shadows are seen, from spontaneous pneumothorax. In one of the slides which Dr. Beeler showed, there was just a beginning separation of the lung near the apex, which showed very clearly the line of the pleura, and suggested Van Zwaluwenburg's pleural gap. We would think from that line which showed so clearly, that Van Zwaluwenburg's gap was in reality the line of the pleura. In this case it was not because it was thickened, but because the lung had begun to collapse; however, it would help to interpret the shadow which Van Zwaluwenburg has so well explained.

Dr. Potter. I think the point Dr. Beeler brought out about the strains that brought on this rupture is interesting. We can easily see how we can get greater intrathoracic pressure from closed-mouth strain than from a cough where outside air is present. The case I saw was a young man who was supposed to be perfectly well. He was cranking a six-cylinder car on a cold night, and did not succeed in getting it going. He had just a moderate pain in his chest, a little bit of shortness of breath—enough to make him see his doctor, who was a very good internist. This was not recognized as a pneumothorax, and he was advised to go down to Asheville and play golf, and maybe he would feel better. He did so, but did not feel better. He would feel a little worse when he got halfway around the course. He came home and went to another internist, who said, "You have a collapsed lung."

It is difficult to make out, from *x*-ray examination after the lung is collapsed, whether it is due to a thinning out of the mediastinum or to a small amount of disease; because after the lung is collapsed, it looks more or less solid and a small amount of disease can be there and not be seen. It is interesting to try to see it. When the patient breathes in, you see the lung absolutely fill up, and when he breathes out, it sinks again at the hilus. You can, during that inspiration, perhaps, get some idea whether there are consolidations inside the lung. After the condition has cleared up, you may be able to say whether there was any disease in the region of the tear.

---

[2] Emerson. *Johns Hopkins Hosp. Rep.*, Vol. xi.

Dr. Hickey. I would like to ask Dr. Beeler if he made any fluoroscopic studies on this case, and if he did, whether he was able to demonstrate the lateral movements of the heart with respiration. We have one case of artificial pneumothorax where this is quite a striking phenomenon. I wondered if it were true in the spontaneous.

Dr. Murphy. I would like to ask if anyone has had experience with pneumothorax with fluid, and if there is any possible way of clearing up the fluid. We have a case in which by positive pressure apparatus we were able to bring the lung back to normal, but the fluid continues to form, and fills the chest almost as fast as we can take it out.

Dr. Beeler (closing discussion). I forgot to mention that the cause of death in this case was double pneumothorax.

In answer to Dr. Crane as to the Van Zwaluwenburg gap, I admit that that is what we thought we had, and from the plates and stereoscopic studies, I would have almost sworn that she had tuberculosis. I saw the autopsy made by the University pathologist, who is a very competent man. Thorough sectioning showed no tuberculosis in any part of the lung.

In answer to Dr. Hickey, I will say that we did fluoroscope the case several times, and were unable to see any movement of the heart. Whether that was due to the number of adhesions that were found, I do not know, but we were unable to show any change in the lateral position of the heart.

ANATOMICAL CROSS-SECTION CHARTS IN ESTIMATING X-RAY DOSAGE*

BY ARTHUR U. DESJARDINS, M.D.

Section on Radium and Roentgen-Ray Therapy, Mayo Clinic

ROCHESTER, MINNESOTA

THE day of haphazard radiation therapy is rapidly passing, as more precise facts are emanating from the laboratories of the physicist and of the research pathologist; and the application of such facts is making more necessary the development of a technique in which methods of precision play an increasingly important part.

As recently stated by Ledoux-Lebard, the idea of treating deep lesions, and particularly malignant tumors of the viscera, by means of *x*-rays, is nearly as old as radiotherapy itself. The fundamental laws governing the action of the rays on tissue cells were laid down years ago as the result of the experimental studies of Albers-Schönberg, Bergonié, Tribondeau, Halberstädter, Regaud and Blanc, Lafargue, Cluzet, Nürnberger, Hudellet, and many others. The application of these laws to the treatment of various superficial lesions has been relatively simple, and has become a routine procedure. However, in lesions beneath the surface of the body, the results have not been so good.

The correct *x*-ray treatment of a given neoplasm requires:

1. Knowledge of the location, extent and type of the tumor, and its relations to surrounding structures, as well as of the existence and location of metastatic foci. It is often difficult, and sometimes impossible, to obtain such complete information.

2. Knowledge of the quantity of rays of a definite quality, or "effective wave-length" necessary to deal successfully with a given type of tumor. A great deal is heard about the so-called "cancer dose," but our knowledge of dosage is not sufficient to warrant the use of such a term. If we are asked what is the cancer dose in a given case, we must admit that, thus far, there is no such dose, and it is doubtful if

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., September 12–16, 1922

there will ever be. This is true, because we do not know enough about the biophysical and pathological phases of tumor growth, and we know still less, if anything, about the quantitative and qualitative effects of x-rays on different tumors of the same type. To discuss this at length would be beyond the scope of my subject.

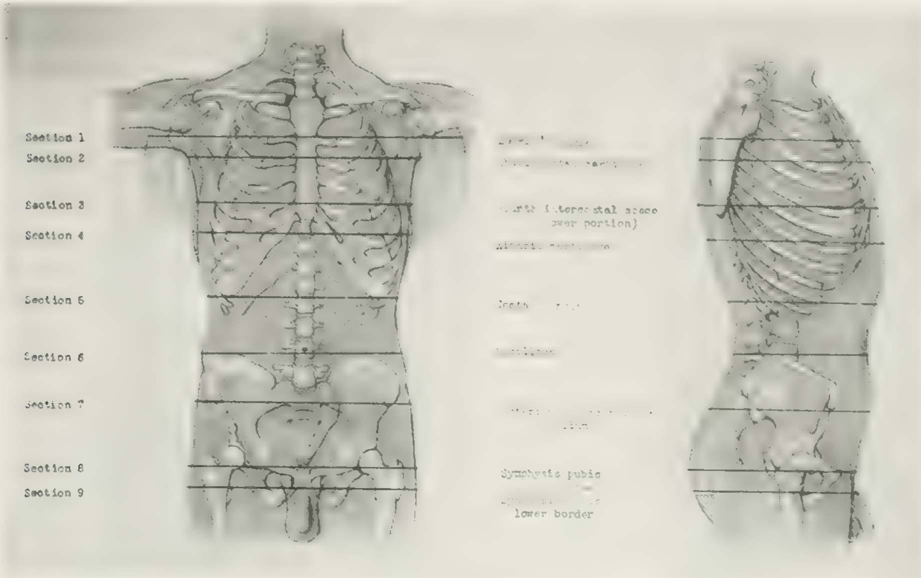


FIG. 1. Levels at which contours and sections were made in male.

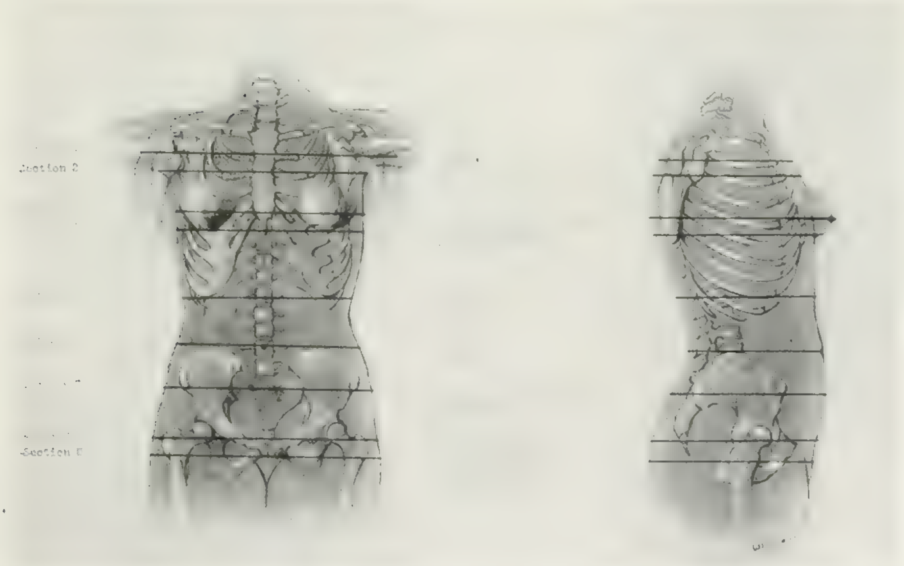


FIG. 2. Levels at which contours and sections were made in female.

3. Knowledge of the absorption or penetration characteristics of rays of a given "effective wave-length." As the result of the introduction by Villard and Szilard, of the ionization method of measuring the intensity of a beam of x-rays, we are now in position to determine, at different depths in the tissue, the percentage penetration of the beam striking the surface.

Whether the radiologist chooses to utilize the well-known penetration charts of Dessauer, or whether he prefers to work from data obtained by his own efforts, and with his own apparatus (this is undoubtedly the better method, provided the radiologist be trained in the use of physical instruments) the intelligent use of such data in a given case requires fairly accurate knowledge of the distance of the tumor from the surface, and as much as possible of the dimensions of the tumor, including foci of dissemination. This involves measuring the patient at the level of the growth preferably in the form of a contour sketch, with relation to which penetration data may be studied.

In this connection it occurred to me that life-size cross-section charts of the average male and female figure would be very desirable, and would enable the radiologist to study his penetration data, and to determine the ratio of depth dose to skin dose with relation to the average human figure.

Anatomies showing cross-sections are now available, but the sections were made from dead subjects, and present a variable degree of distortion. In only one such atlas, to my knowledge, are the sections life-size, and these were made from one body only.

In order to fulfill the foregoing requirements and to meet the objections, a series of life-size cross-section charts of the trunk of the average male and female body were prepared. To obtain such an average, or what might be termed "ideal" male and female figures, twelve well-formed male, and twelve female subjects, were selected varying in weight between 100 and 200 lbs.; in height, between 64 and 74 in.; and in age, between twenty-five and forty years. Of each subject, a series of careful contour measurements at different levels was made. For obvious reasons, the levels selected correspond to prominent and easily recognizable surface landmarks. Figures 1 and 2 show the levels at which the contours were made.

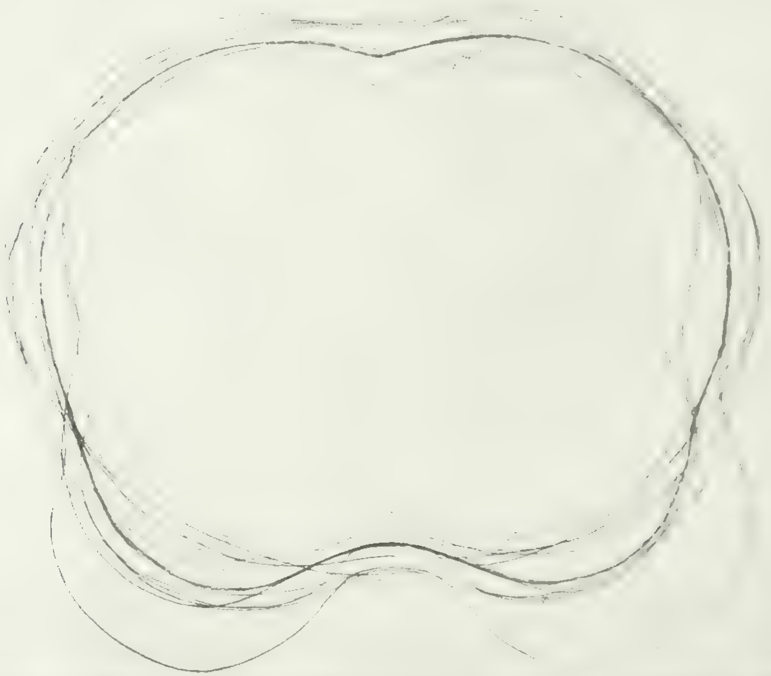


Fig. 3. Composite contour tracing of twelve female subjects at the level of the lower portion of the fourth intercostal space.

The number of levels measured and charted is thought to be sufficient for most purposes, although in foreign body localization, it might be desirable in some cases to have a larger number to cover intervening points.

The contours at each level were then brought together, and a composite made at each level for the twelve male and for the twelve female subjects, and from each of the composites an average contour was traced. Figure 3 shows one of these composite contour tracings, and also the "average" contour traced from it.

The method employed in making the contour tracings was as follows:

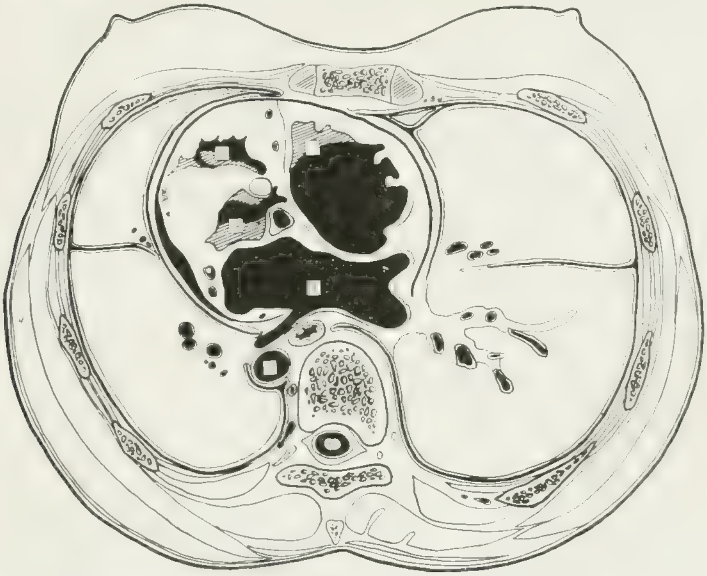


Fig. 4. Contour and cross-section of the average female at the level of the lower portion of the fourth intercostal space.

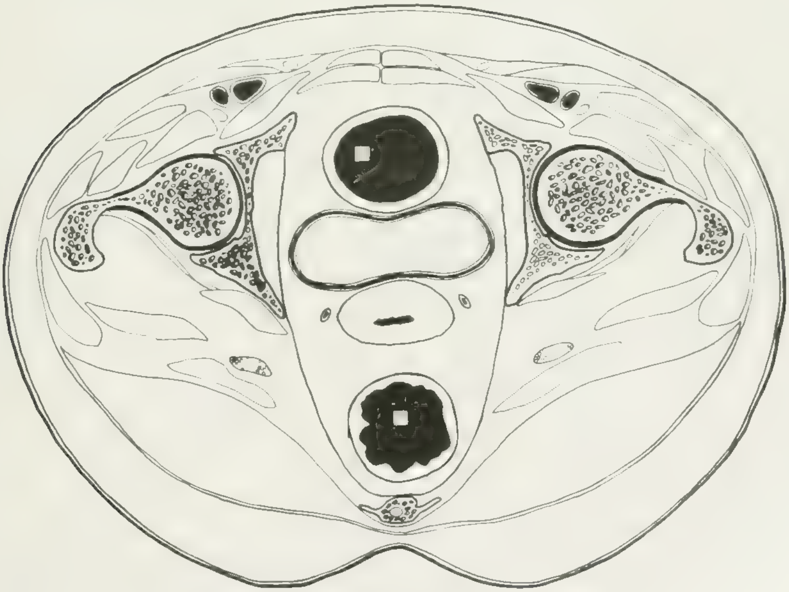


Fig. 5. Contour and cross-section of the average female at the level of the upper border of the pubic symphysis.

The subject was instructed to stand straight, with feet well together, but with no muscular effort. The level was determined and indicated on the skin. A piece of rubber tubing was passed over a heavy lead wire, the whole being readily malleable and yet stiff enough to hold any position. The median line having been determined at a given level, the middle of the lead wire was placed in contact with the skin at this point, a corresponding mark being made on the rubber tubing. The ends were then molded to the surface, an assistant maintaining the contact behind as the wire was adjusted anteriorly, where the mid-line was similarly determined and marked. After it had been determined that the contact was perfect all around, and free from undue pressure, the effect of respiration was studied in order to learn as accurately as possible the point midway between ordinary inspiration and expiration.

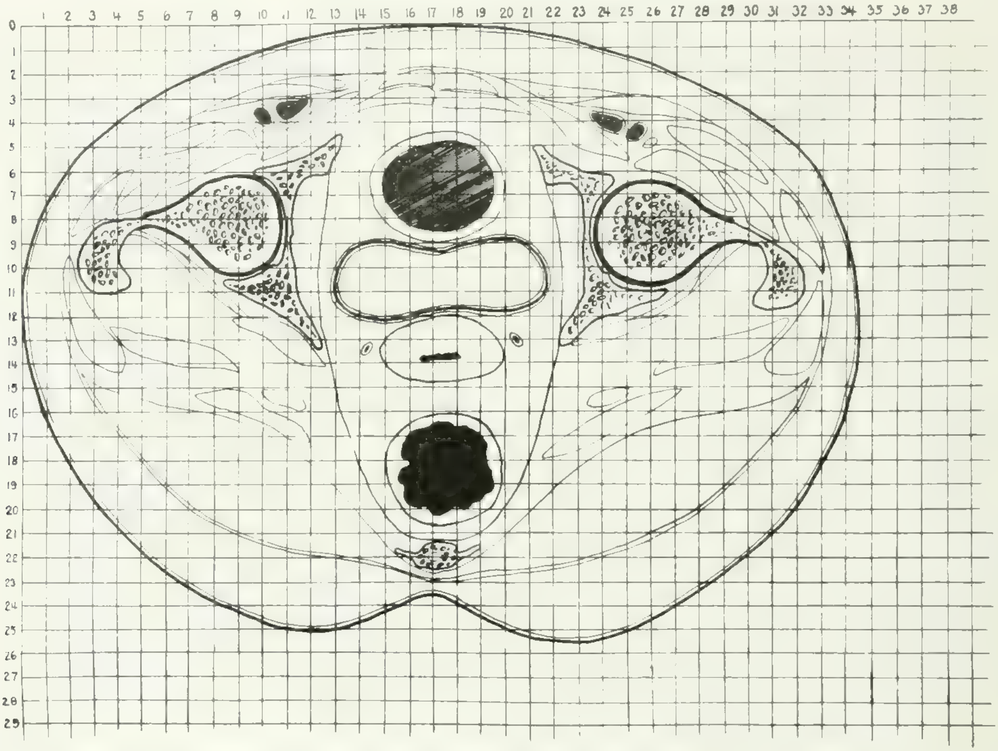


FIG. 6. Shows how the measuring chart makes possible measurements of any portion of the cross-sections.

The wire was then removed, by slipping either upward or downward, and transferred to a sheet of paper. Before tracing the contour on the paper, careful measurements of the anteroposterior and transverse diameters of the body at that level were made by means of a large caliper, and the contour as represented by the lead wire checked in these two dimensions, after which the contour was traced on the paper.

In charting the outline of the internal structures, information was gathered from several standard anatomies, such as Gray, Deaver, Piersol, Spalteholz, Sobotta and McMurrich, and the cross-section charts of Professor Symington and of Professor Eycleshymer.

More or less discrepancy exists in the description by different anatomists of the location of certain structures, such as the umbilicus. This is not at all surprising to one who has examined a number of dead bodies. Eycleshymer places the umbilicus opposite the intervertebral cartilage between the third and fourth lumbar vertebrae. Davis places it opposite the intervertebral cartilage between the fourth and fifth lumbar vertebrae. As a matter of fact, in the average body the umbilicus is to be found opposite some portion of the fourth lumbar vertebra.

Another example of such discrepancy is to be found in the female breast. There is a very considerable difference in the size of the breasts and in the tonicity of their tissue components; this accounts for a wide variability in the location of the nipple.

A striking instance of variability in location may also be seen in the uterine cervix, the exact position of which varies with the degree of distention of the bladder, the state of the rectum with regard to its contents, the position of the uterus itself as affected by lacerations of the pelvic outlet, and other pathological conditions around the pelvis. In all such instances an endeavor was made to strike an average between the extremes.

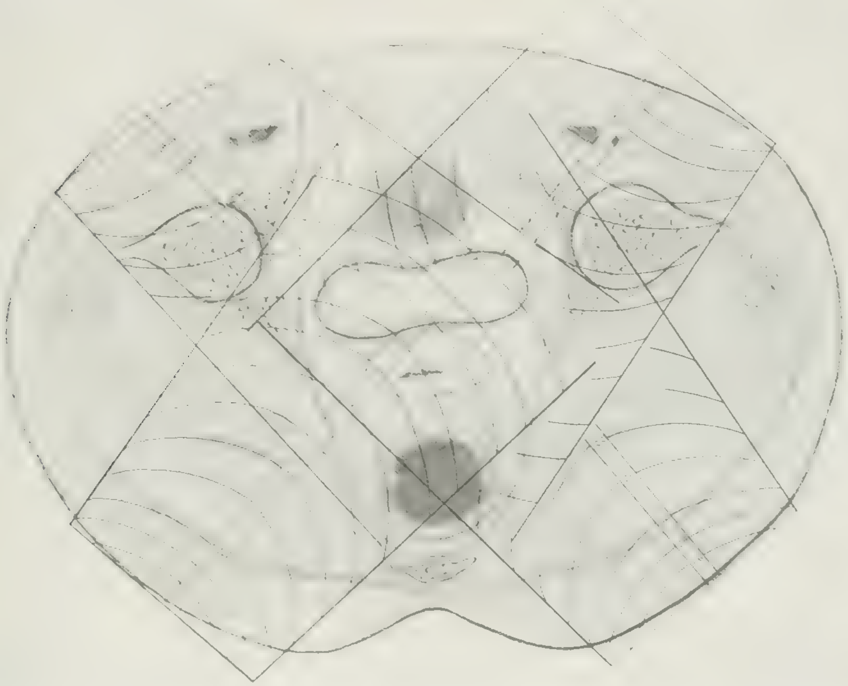


Fig. 7. Contour and cross-section of the female pelvis (upper border of the pubic symphysis) studied with relation to Dessauer's penetration data: kilovoltage 181.5; ma. 2; filter 0.8 mm. copper and 1.0 mm. aluminum; distance 50 cm.; size of field 10.1 cm × 13.4 cm. Owing to the confusion produced by extending all four cones through the uterine region, only one complete cone is shown.

Figure 4 shows one of the charts of the female thorax at the level of the lower portion of the fourth intercostal space. On looking at the actual chart (this is not apparent in the reproduction) the first thought that comes to one's mind is: "That cannot be a true section of an average-sized woman; it looks too small."

Figure 5 is a section of the female pelvis at the level of the upper border of the pubic symphysis—the level corresponding to the junction between the cervix and body of the uterus. Again, one is struck by the apparently small size of the section. That impression obtains throughout and is especially striking in connection with the sections in the region of the lower thorax and upper abdomen. The charts all look small compared with one's conception of the size of a human being. Contour measurements of a large man or woman weighing 200 lbs. will invariably look much smaller than one would expect from the appearance of that individual. However, if the section circumference be measured, one will soon be convinced that appearances are deceptive.

These charts will assist the radiologist in applying or studying penetration data with relation to the average patient, but will not remove the necessity or advisability of measuring patients, especially such as are patently larger or smaller than the average.

By means of a measuring chart graduated in centimeter squares and printed on transparent celluloid, it becomes a simple matter quickly to obtain any measurements desired. Figure 6 illustrates the use of the measuring chart.

Figure 7 shows the section of the female pelvis, at the level of the upper border of the symphysis pubis, studied with relation to Dessauer's penetration data under the following conditions: kilovoltage at tube terminals, 181.5; ma., 2; filtration, copper 0.8 mm. and aluminum 1.0 mm.; anode-skin distance, 50 cm.; size of field, 10.1 × 13.4 cm. From this it may be seen that for each field treated, about 30 per cent of the surface dose penetrates to a depth of 15 cm., roughly corresponding to the position of the uterus with the rays focused at the angle shown. If we may accept Dessauer's values as at least approximately accurate, treatment through four such fields will enable us to deliver a fairly uniform dose representing 120 per cent of the skin dose taken as 100 per cent.

There are so many methods of foreign body localization that no attempt is made to show their use in conjunction with the charts.

INJURIES FROM ROENTGEN RAYS IN DEEP THERAPY*

BY HERMAN WINTZ, M.D.

ERLANGEN, GERMANY

THE results obtained during recent years by the employment of deep roentgen therapy have fully justified the claims made for this newer form of treatment. Though it may be said to be still in its infancy, I venture to predict that the successes obtained by this mode of treatment will increase from year to year.

The introduction of a new therapeutic measure has always been accompanied by an over-estimation of its curative powers, which, in the course of time, had to be modified when a more mature judgment prevailed. In deep roentgen therapy we are threatened with a set-back on account of a variety of injuries resulting from the therapeutic application of the rays.

For this reason, I think the time has arrived to arouse a general interest in the dangers involved in deep roentgen therapy and to call attention to the dangers inherent in the agent, and not attributable to its careless use.

It is not necessary to refer to those phenomena with which every roentgenologist is sufficiently acquainted—the so-called "*x*-ray burns." They are the results of overdoses which exceed the limit of tolerance of the exposed tissues, and which, in the majority of cases, are attributable to the careless or unskilled handling of a roentgen apparatus or to technical defects in the appliance, such as a non-functioning milliampèremeter or a faulty chronometer.

It must be expected that a conscientious and expert roentgenologist manipulates his apparatus so skilfully that he will notice such disturbances at once, and that he will not entrust his work to poorly-trained attendants. *X*-ray burns should not occur under an expert management. However, roentgen injuries have occurred and will occur in the future, and cannot be avoided with absolute certainty. But it is also true that certain accidents may happen after surgical interference.

These injuries may be divided into two groups: local and general injuries.

I. LOCAL INJURIES

1. *Injuries Caused by Exceeding the Limit of Tolerance of Tissues, and Resulting from the Defects of Our Present Radiation Technique.* The medical technique of the deep roentgen therapy is based on the fact that it is almost never possible to apply, through a single field of entrance, the amount of rays necessary for the destruction of a malignant tumor. Hence, multiple ports of entrance are necessary. This requirement, however, contributes to the

---

* Read by title at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., September 12-16, 1922.

danger of overdosing, regardless of an otherwise exact technique. This danger is augmented by the fact that the dose of roentgen rays necessary for the destruction of the carcinoma (carcinoma dose) represents a quantity of rays which approaches the dose that can just be tolerated by the mucous membrane of the large intestine and the bladder. These posological difficulties are increased by the fact that the quantity of primary rays introduced into the body is being increased or lessened in a manner not easily determinable by the size of the irradiated body volume and its varying density. The latter depends on the varying composition of different parts of the body.

For the irradiation of the body, those values are generally selected which have been obtained by measurements in the water phantom. It is evident that the diffusion of rays in a known volume of water cannot be identical with the diffusion of rays in a like volume of the body which may contain the muscular apparatus, the gall-bladder, the intestines with extraneous contents, and the bladder. The latter, particularly, is being gradually filled during irradiation. In the radiation, through different fields of entrance, of cervical cancer which lies at an average depth of 10 cm., the sources of error just mentioned are compensated for. But conditions are quite different for the superficial layers of tissue.

Based on results of radiation measurements in the wax or water phantom, and on the cadaver, we treat cervix cancers through 6 or 7 fields of entrance, each field being 6 by 8 cm. These fields of entrance must, of course, be placed close together, as shown in Figure 1. If the skin in each case is exposed to 100 per cent unit skin dose (U.S.D.) there will remain an intensity of rays of 65 to 70 per cent of the U.S.D. at a depth of 2½ to 3 cm. The intensities of rays at the adjoining sides of 2 fields of entrance are increased by a summation of the lateral intensities of the 2 fields to which eventually must be added a third field, the vulvar field. Therefore, it is almost impossible to avoid raying some parts of the anterior wall of the bladder by a quantity of rays which approximates 150 to 160 per cent of U.S.D. If, during radiation, the bladder is not emptied at least every hour, the fundus vesicae, or rather the anterior wall of the bladder, will be forced closer to the anterior abdominal wall, and thereby nearer to the roentgen tube. The quantity of rays striking the anterior wall of the bladder will then be still further increased. In the latter instance an injury will occur, manifesting itself principally in blistering and an edema of the vesical wall. A real burn and the formation of an ulcer in the mucosa of the bladder may also take place. As the muscles bear a stronger dose than the mucous membrane, only the epithelial coat of the bladder will be injured.

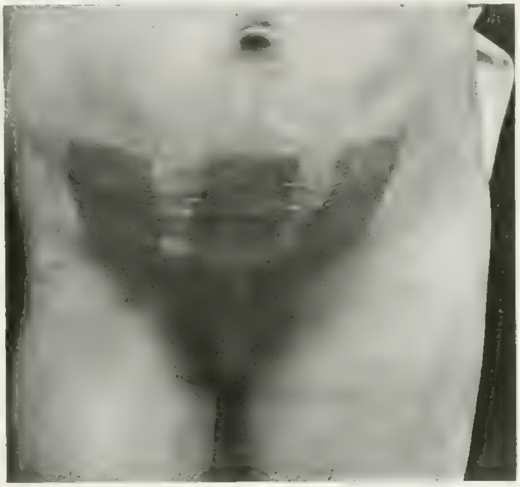


Fig. 1. Location of fields on suprapubic region.

The rectal mucous membrane is also subject to similar injurious factors. The anterior wall lies close to the portio, and all the cones of rays are focused on it. If the radiation is carried out carefully, the anterior rectal wall will not be endangered. However, the posterior wall of the rectum lies within reach of at least 3 fields of entrance. In thin patients, the region of the posterior rectal wall may be exposed to a radiation dose of about 140 to 150 per cent of the U.S.D.

Experience teaches that this overdosing will occur only in small isolated areas of the mucosa, and ulcers will form. But it is also possible that ulcers may secondarily result from vascular injuries and, eventually, from the secondary rays which arise in the contents of the bowel.

An *x*-ray injury of the small intestine, due to the overlapping of several radiation cones, is rarely observed, owing to the fact that the small intestine is mobile and easily pushed out of the field of irradiation at each new adjustment of the compression tube. But if several loops of the small intestines are fixed by pelviperitonitic adhesions either to each other or to the uterine tumor, a certain loop of the small intestine may be exposed to several cones of rays, and the same danger prevails then as described for the bladder and the large intestine. Various injuries have been observed in the small intestine. Some of the least serious are glandular atrophy, partial injuries of the vessels, partial necroses of the mucosa and ulcers of the mucous membrane. In general, injuries of the small intestines are less frequent, and, if occurring, are always due to one or the other complication. Injury to the lower portion of the ileum is the most likely to occur.

The mucous membrane of the small intestine is about 30 per cent of the U.S.D. less sensitive to the action of the rays than the mucous membrane of the large intestine.

If, in cases of mammary carcinoma, the supraclavicular glands and the lymphatic chains along the sternocleidomastoid muscle are infiltrated and, consequently, need treatment, an injury to the larynx and trachea is likely to occur. This danger is the more imminent if the right and left sides of the neck must be exposed to a dose of approximately 95 to 100 per cent at a depth of 2 cm. in order to affect the carcinomatous glands. If these 2 fields converge in the center, a dose of 150 to 160 per cent will strike the laryngeal mucosa. This dangerous dose applied to the larynx may be reduced by placing the patient in an appropriate posture and tilting and shifting the tube. But even then, the larynx will be exposed to a dose of rays lying between 120 and 130 per cent of the U.S.D. The injury will manifest itself by hoarseness and, eventually, complete aphonia, which may persist from two to four weeks; besides, there will be a sore throat and dysphagia. A somewhat larger dose (150 per cent) will render the laryngeal mucosa edematous and we are confronted with the danger of an edema of the glottis.

The injuries resulting from such a radiation can be lessened by raying each side of the neck separately, allowing an interval of several days between treatments. But in certain classes of cases this cannot be done, and it is particularly not advisable in the irradiation of a laryngeal carcinoma with carcinomatous infiltration of the adjoining parts. In such a case, separate radiations would mean a dissipation of the dose, and the dose required for the destruction of the carcinoma would be too small. Injury, namely, ulceration, results from the fact that the limit of tolerance of some of the elementary tissues is exceeded by the administration of too large a dose of primary rays.

2. *Injuries from Uncommon Secondary Rays.* There is another factor responsible for the occurrence of injuries: namely, the addition of a radiation intensity derived from uncommon secondary radiators. Thereby the radiation dose is increased though the primary radiation was correctly gauged and did not exceed the limit of tolerance of the tissues. We must always consider the possibility of such injuries resulting from the use of opaque meals: e.g., barium meals employed in fluoroscopy which have not been removed from the gastrointestinal tract by careful irrigation. Fecal masses may also act as generators of secondary rays. Furthermore, injuries to the bladder have been observed in cases in which collargol was injected into the bladder and the pelvis of the kidneys a few days prior to irradiation. Such injuries are, as a rule, trivial, because the fluorescent and beta rays emanating from the collargol (silver) are of low penetrating power. An illustration of an injury of this kind may be demonstrated by the following experiment: A healthy part of the skin is treated with "copperization." The process is executed as follows: A sponge electrode, saturated with a 5 per cent copper solution, is placed on the right side of the abdomen and an indifferent cathode on the back. A weak galvanic current of

20 ma. obtained from a storage battery is applied for four hours. The part of the skin which had been treated with copper is irradiated with an accurately measured dose of roentgen rays of 90 per cent of the normal U.S.D. (Iontoquantimeter—U.S.D.) The corresponding left side of the abdomen is also irradiated with the same dose. After four or five weeks we will observe on the left side of the abdomen a delicate yellowish-brown discoloration, corresponding to the margins of the field: while at the same time on the right side of the abdomen, where the copperization has been done, the skin exhibits a second degree erythema, which otherwise would have been attained with 120 to 130 per cent instead of 90 per cent of the U.S.D. (Fig. 2).

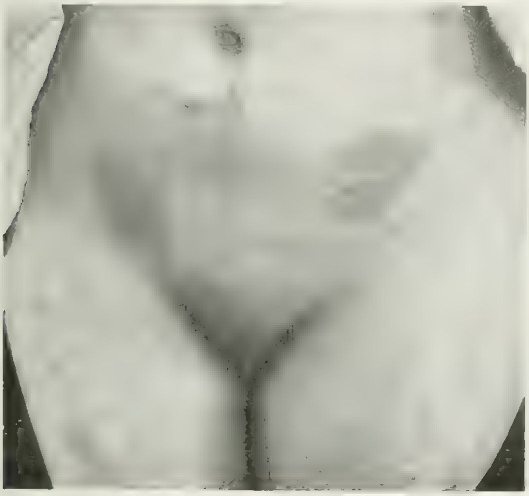


Fig. 2. Showing the more intense effect of x-rays on skin saturated with a secondary radiator than on untreated skin.

3. The Lowered Resistance to Injuries of Irradiated Tissues. The injuries described in the foregoing chapter are not surprising, for each overdose is bound to produce injuries to the tissues. In contrast to this, our observations show that every irradiated part of the body exposed to a quantity of rays exceeding the limit of tolerance typical for the cells by one-third, forms an area of lessened resistance towards irritants applied to it.

The knowledge of these *loci minoris resistentiae* is of paramount practical importance, for it explains the peculiar injuries which have been observed after correctly applied treatments, and particularly the so-called "late" injuries.

From a pathologico-anatomic viewpoint we are dealing principally with vascular changes. Changes in the metabolism of the cells are also quite probable. Such *loci minoris resistentiae* are observable in every irradiated part of the skin. We have established a dose of rays which is tolerated by the skin without producing any pathological changes: namely, a dose of 100 per cent of U.S.D. Irrespective of the fact that a pigmentation will appear on the irradiated area, after the exposure to the dose just mentioned, there will be observed neither a thickening of the skin nor an infiltration, nor even a desquamation. The pigmentation will slowly fade away in the course of two or three years.

If we employ a dose of less than 100 per cent of the U.S.D., e.g., 80 per cent, only a faint pigmentation is to be observed; and with a dose of less than 70 per cent, pigmentation will not occur. If to the effect of the x-rays upon the cells another irritant is added, which normally would cause no injury at all, the skin will respond to the summation of the two irritants with a distinctly recognizable reaction. Factors that may incite such a reaction are persistent pressure upon the irradiated part of the skin, the application of ice-bags, hot compresses, and chemical changes produced by the administration of internal remedies. To illustrate: The abdominal skin of an otherwise healthy (female) patient is exposed to 80 per cent of the U.S.D. About twelve to twenty-four hours after such an irradiation, a faint reddening of the irradiated part is to be observed (early erythema) which disappears after a short time. After four to five weeks, a delicate yellowish-brown pigmentation is to be seen in the irradiated part. If the patient takes a warm bath on the second day after irradiation, the early erythema will be considerably increased. After from eight to ten days another reddening will occur and the pigmentation also will be more distinct. The same effect may be produced by the application of an ice-bag or a hot electric pad or a hot-water bottle. By the employment of a dose of 100 per cent U.S.D. the reactions will, of course, be stronger.

Irritants due to customs of daily life comprise pressure by the corset, waistband, bodice, and sometimes, braces. Such an instance of increased reaction in a part of the field of irradiation is shown in Figure 3.

This patient underwent irradiation for mammary carcinoma. The size of the dorsal field is shown on the photograph. On a level with the shoulder we note a pronounced brownness with desquamation. The picture conveys the impression that small fields of entrance had been employed in addition to and within the delicately browned large field of entrance. However, this was not so. The markedly pigmented spots correspond exactly to the straps of the basket which the patient used to carry.

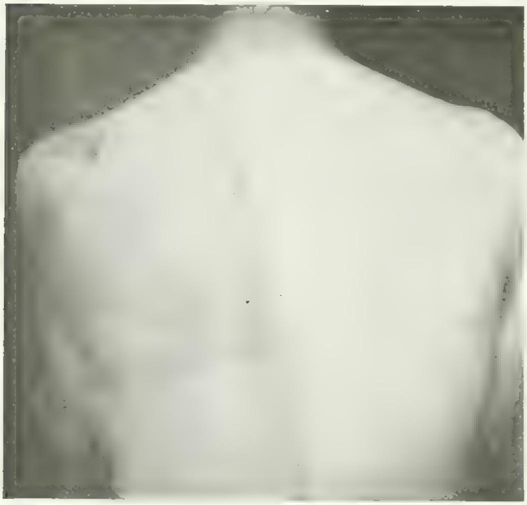


Fig. 3. Effect of long-continued pressure on a radiated area of skin.

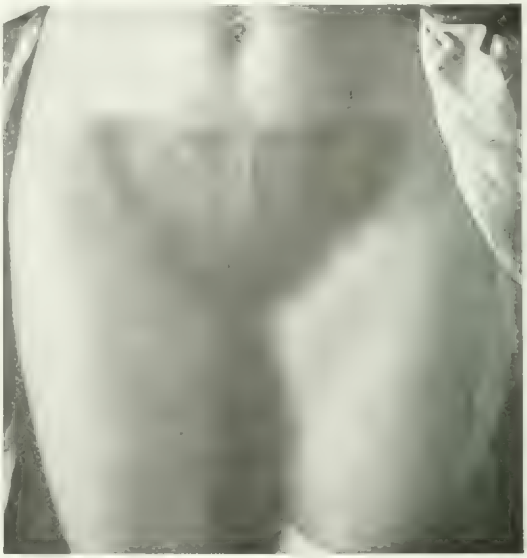


Fig. 4. Action of chemicals on skin exposed to a 100 per cent U.S.D. of *x*-rays.

Figure 4 shows a reaction which should correspond to the administration of a dose of rays of 120 to 130 per cent of U.S.D. However, in this case only 100 per cent of U.S.D. was employed. The dorsal fields show quite a marked brown pigmentation. The apparent overdose was due to the application of a concentrated solution of lysol which the patient sometimes used to wash the irradiated parts of the skin.

In the cases just mentioned, the injurious influences were but slight, and therefore followed by correspondingly weak reactions. It follows that severe traumata of irradiated parts of the skin may produce serious injuries. This fact readily explains the frequent occurrence of those startling "late" injuries. Thus we observed a case in which the skin area irradiated with 100 per cent of the U.S.D. received a strong blow with a heavy piece of wood. The result was a superficial necrosis, covering almost the entire field of irradiation. Even if such traumata occur from two to three years after irradiation, ulcers may develop on the irradiated skin which resemble those caused by burns. As a rule, they exhibit a better tendency to heal than the primary ulcers produced by over-radiating.

In discussing the causation of the *loci minoris resistentiae* we proceeded from the presumption that the irradiated part of the body was exposed to a single dose, from which a primary injury could not be expected. But if the same dose is repeatedly employed in the same part of the body, then the total of the macroscopically demonstrable injuries will produce a peculiar picture; namely, the roentgen induration. The skin, which was irradiated with a dose of 100 per cent of U.S.D., two, or at the most, three times, at intervals of from six to ten weeks, becomes leathery and thick, feels tough and hard, and presents an edematous appearance. The cause of these changes is undoubtedly to be found in vascular injuries and an enhanced permeability of the vessels. The other tissues, including the muscles and the connective tissues, will also react in a similar manner. The power of resistance of tissue thus injured towards further additional injuries, such as traumatic and chemical noxae, or infection, is considerably lowered.

If during the period of the infiltration (induration) the skin is protected against all injurious influences, the condition will recede in from one to one and a half years. Far more dangerous is the infiltration of the pulmonary tissue which may appear after irradiations of mammary carcinomata or lung tumors. The examination findings of such a lung resemble those of a central pneumonia; there is no fever, but a slight irritative cough. The affected part of the lung is, of course, useless. This condition is also comparatively harmless and will recede spontaneously in the course of one-half to three-fourths of a year. If an intercurrent disease (pneumonia or bronchitis) complicates the radiation induration, then the prognosis is almost always bad (Fig. 5).

The prevention of the infiltrations of the pulmonary tissue is of decided importance if we wish to improve the results of radiation therapy of mammary carcinoma.

Just as the slightest injury following irradiation will increase the skin reaction, so acute or chronic diseases which are present in the tissue prior to the irradiation may incite an increased reaction.

A greatly increased reaction is to be noted with every gross change in the tissue, because the roentgen treatment introduces an additional noxious agent. Even when the skin is only slightly irritated, this increased reaction may be observed.

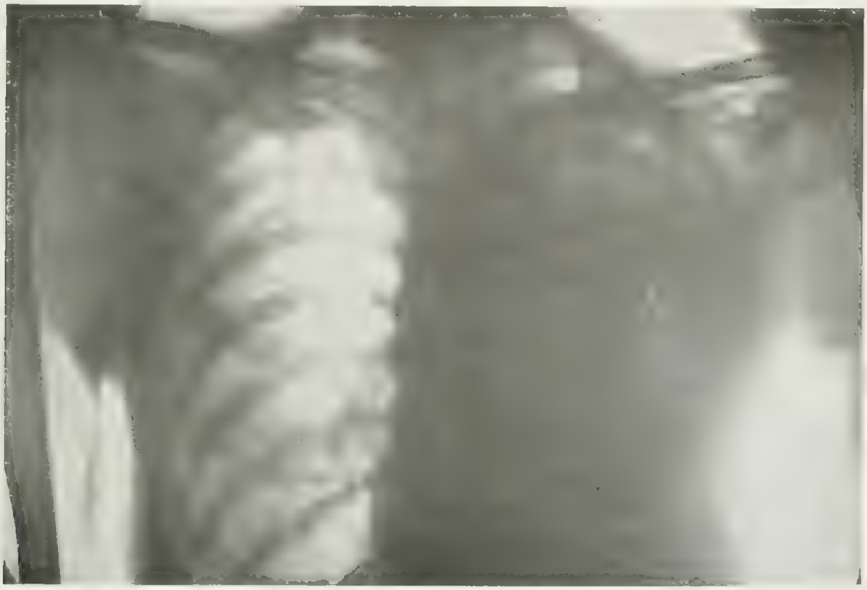


Fig. 5. Radiation induration of the lung.

Figure 6 shows a slight irritation of the skin in the anal region at that point in the field of irradiation where previously an inflammatory erythema was located. Attention is also called to the inflammatory reaction of the tissue in radiations of the ovaries when diseased adnexa exist. This explains the rise in temperature, as well as the slight parametric thickenings which are observed after the irradiation of myomata, climacteric bleedings or severe uterine hemorrhages. They are attributable to inflammatory adnexal disease. The reaction will be also increased if the cells are not visibly changed, and where a systemic disease causes an injurious influence upon the cell. The investigations carried out by Seitz and myself demonstrate that the skin of Basedow patients is about 30 per cent more sensitive than the normal skin. The skin in certain varieties of diabetes is likewise more sensitive, and in lues also an increased reaction has been observed.

That copperization produces an injury to the cutaneous cells, and thereby an increased reaction of the skin, has been pointed out: the same may occur after a single long-continued galvanization of the skin.

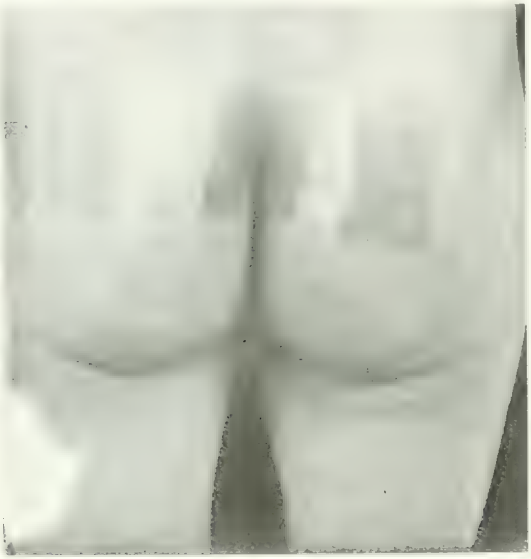


Fig. 6. The more intense action of rays on erythematous skin area in comparison to that on normal skin.

Therefore, if a primary overdosing with *x*-rays can be excluded, and roentgen injuries occur, the possibility is that they were caused by a combination of injurious influences either before or after irradiation. The conception of "late" injuries is thus explained.

II. GENERAL INJURIES

Local injuries must be distinguished from general or systemic injuries. The latter may affect the patient as well as the roentgenologist and his employees. Omitting, for the present, the consideration of injuries due to unsuitable apparatus or manifestly careless manipulation of the same, as well as the traumata caused by high tension currents, burns and the like, there remain two factors which may be considered as typical roentgen dangers; namely, blood injuries and the inhalation of the air of the roentgen room and surges which can only be avoided by special devices.

Acute blood injuries result from acute destruction of the blood corpuscles. They follow a long-continued irradiation and are observed only in the patient. The chronic blood injuries affect the personnel, and are due to the effects of the *x*-rays as well as the "roentgen air."

Destructive changes in the blood occur during each therapeutic irradiation which is employed for the destruction of pathologic cells. The smallest quantity of rays introduced into the body corresponds to the dose ordinarily administered in castration irradiation. In order to determine the quantities of rays introduced into the bodies of different patients, it is necessary to express the quantity of rays by a new unit, for the posologic determinations hitherto in vogue refer to the amount of rays which act at the seat of the disease. Under given circumstances, a comparatively large dose may be measured in a certain part of the body, although the total amount of rays introduced into the body may be smaller than that which was administered at the seat of the disease.

The unit called "a" corresponds to the quantity of *x*-rays generated at about 180 kv., filtered with 0.5 mm. zinc, passing through a volume of tissue the size of a pyramidal stump, the upper surface of which is 6 × 8 cm., the altitude 15 cm., and the apex, i.e., the tube focus, is 23 cm. above the upper surface.

We must bear in mind that the kind of different tissues of the body also plays a rôle in these calculations. Our computations show that for the entire trunk these differences nearly compensate each other. If doses of from 2½ to 3 "a" are introduced into the body, the first recognizable blood injuries will occur; these are easily counteracted by the body. Also a blood injury caused by 5 to 7 "a" will be overcome after from five to six weeks, provided that a hemoglobin content of more than 40 per cent and an amount of leucocytes of over 2,500 existed before the radiation. In the castration irradiation, the amount of the dose is 4 "a," which, therefore, may unhesitatingly be administered to exsanguinated patients. The quantity of rays necessary for the irradiation of a uterine carcinoma is 6 to 8 "a," and does not result in an irreparable blood injury. For the mammary carcinoma we need up to 12 "a." Also with such a dose introduced into the body, a restoration of the blood picture to normal is regularly observed.

This comparison of the volume of the radiation cones leaves out of consideration the biological factors of the system. The most important are the functional capacity of the blood-forming organs and the ability to destroy the toxins (roentgen toxins and toxins resulting from the disintegration of the tumors). In a scientific investigation these factors must not be overlooked, nor the fact that the intensity of the *x*-rays within the time-unit is of importance. In a long-continued irradiation (roentgen therapy in one sitting with a large skin-focus distance) one may observe that the blood injury does not occur to a degree one might have expected, based on the computation made with the magnitude "a" previously described. This deduction is important because it shows that there exists an optimal irradiation period for distant radiations, and that the necessity of a great intensity of the rays within the time-unit is justified.

The injuries caused by irradiation also include the so-called "Roentgen Kater," the nausea produced by irradiation. This is not the place to enter upon the various discussions devoted to this condition. We only wish to state briefly that in the literature the view is being more and more advanced that the expression "Roentgen indisposition" is too mild for this general systemic disturbance. According to our findings—not taking into consideration the nervous factor, which plays an important rôle in "Roentgen indisposition"—actual changes in the biochemistry of the cells take place under the influence of the *x*-rays by an injury of the cell-lipoids. Furthermore, it is important to state that the charging of the patient with 3,000 to 4,000 volts, corresponding to the tension employed today, and the constantly occurring charges and discharges exercise decisive influence upon the function of the cells. Of practical significance is the fact that the roentgen indisposition is less severe or does not occur at all if the patient is either grounded, or, better still, is protected from the electrical charges by an appropriate screening (faradic cage).

The general injuries of the personnel are chiefly the chronic blood changes which appear with long-continued work with the *x*-rays. They consist of a rather high percentage of eosinophilic leucocytes (10 to 15 per cent) and of a leucocytosis (10,000 to 14,000).

The injurious agents to the personnel are mainly found in the air which has been vitiated by the electrical surges, and particularly by the ozone generated from the air by the *x*-rays. Direct exposure of the personnel to the *x*-rays should not occur in a well-conducted *x*-ray laboratory. Finally, it might not be amiss to point out that defectively grounded lead-lined protecting partitions or badly arranged high tension wires may cause certain injurious influences. The danger consists in the fact that during irradiation an electric field is formed around the lead-lined walls within which the workers are either sitting or which they continually cross by walking around in the roentgen room. The charges and discharges thus generated in the cells of the body are liable to disturb the metabolism of the cells.

The above observations have disclosed quite a number of dangers inherent in deep roentgen therapy. However, many of them cannot be avoided, in spite of the best technical and medical construction of the apparatus, and the most thorough instruction of the technical and medical personnel. The knowledge of the therapeutic value of modern deep roentgen therapy will stimulate a systematic and correct investigation in order to avoid dangers, and thereby contribute more and more to the success of deep roentgen therapy.

FURTHER OBSERVATIONS ON THE RADIUM TREATMENT OF CANCER OF THE ESOPHAGUS WITH A REVIEW OF FORTY-FOUR CASES SO TREATED*

BY R. WALTER MILLS, M.D., AND JOHN B. KIMBROUGH, M.D.

ST. LOUIS, MISSOURI

THROUGH the kind invitation of your society it is our pleasure to address you on the subject of the "Radium Treatment of Cancer of the Esophagus" and to report the results of a series of 44 cases so treated. We previously presented case histories of the first 11 of these before the American Gastroenterological Association, in 1919, indicating results at that time, the published paper appearing in 1920. Since our present attitude is essentially that mentioned in the paper referred to, it seems perhaps best to review the position expressed at that time.

It was emphasized that cancer of the esophagus is one of the truly terrible diseases for which there is not even an adequate palliative treatment, to say nothing of a cure; and that it is an evident obligation to report the results of any treatment that offers a semblance of relief to the victims of the disease.

It was mentioned that cancer of the esophagus, aside from its unfortunate position and consequent security so far from successful surgical attack, is tantalizingly one of the most favorable of the internal carcinomas for treatment in that its symptoms are made manifest at a comparatively early stage by the resulting obstruction; that the type of cancer is usually epithelioid—amenable to radiation therapy; that carcinoma of the esophagus forms a naturally restricted tumor which will act as its own protective barrier; and that metastases occur probably later than in the instance of any other internal cancer.

Certain principles applicable to the use of radium generally, and common in cancer of the esophagus, were reviewed. These principles are familiar to all of you: the necessity for a knowledge of the exact location and physical peculiarities of the tumor; the necessity for as large a dose as can be tolerated with reasonable safety by normal tissue; the necessity for intimate contact of the radium with the tumor, and for a mechanical means of so emplacing it, maintaining it in position and permitting of ready withdrawal by an unskilled person in case of emergency.

SCHEMA OF CLASSIFICATION

Present Classification	Previous Classification
Cured.	
Palliative result good	Definitely successful palliative
Palliative result fairly good	Successful palliative
Palliative result fair	Moderately successful palliative Fairly successful palliative
Palliative result fair only	Slightly palliative
Palliative result negative	Poor result

FIG. 1. Schema of classification of results of radium treatments. This classification has been very carefully adhered to, and every detail of each case reviewed and curves plotted, after the manner of those illustrating this article, to summarize the general results.

It was stated that roentgenoscopy and, in less measure, roentgenography afforded a unique means of aiding in the emplacement of the radium within the cancerous stricture, and of observation as to the permanency of such emplacement to a degree not equaled by esophagoscopy or approached by the old blind method. A method of emplacing radium under *x*-ray control was reviewed. The radium in a capsule of ordinary type with suitable filters of brass, German silver and rubber, was mounted on a rubber-covered wire of a certain texture and introduced after the manner of an ordinary esophageal sound, and when the terminal was favorably emplaced within the stricture the applicator was fixed in position by a head bandage and left *in situ* for a period of hours.

The results of the treatment of the 11 cases were summarized as palliatively good, without any case giving such evidence as would suggest that a cure had been effected.

It may be repeated that our present position after the additional 33 cases to be reported, is essentially the same; though it might be mentioned that one of the

---

* Read by invitation at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

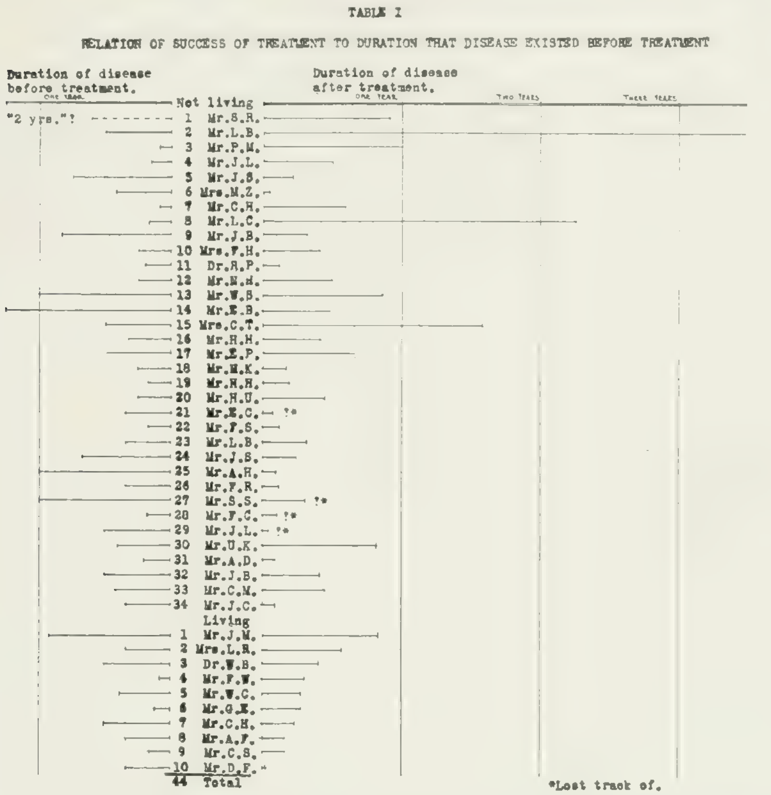


Fig. 2. Table illustrating success or failure of treatment as to longevity after radium treatment; also duration of disease before treatment, which curiously seems to bear little relation to the length of life thereafter. The very variable length of life after treatment probably reflects different histological nature of the lesion.

cases referred to in our first paper lived three and a half years, dying finally of pulmonary tuberculosis and exhaustion, and that an autopsy gave findings encouraging as to the future possibilities of the method. Moreover, with recent modifications of the technique, using stronger dosage, palliative results have been better.

It seems probable that the radium treatment of cancer of the esophagus is destined to be supplemented, though hardly replaced, by modern massive high-voltage *x*-ray therapy. During the past few weeks we have been treating all cases under observation with this method in addition to the use of radium. The results so far have not been striking. It would seem that the present series, with the exception of these few latter cases, having been treated by radium alone, will have future value in that it affords a criterion as to the result of radium therapy probably not possible in the future on account of the obligation to use *x*-ray therapy as a supplement.

Table II

GENERAL RESULTS OF RADIUM TREATMENT

Cured*	0
Palliative result good	12
Palliative result fairly good	12
Palliative result fair	14
Palliative result fair only	3
Palliative result negative	3
Total	44

* Ten cases still under observation, including the most favorable ones treated by recent, more vigorous methods.

Fig. 3. A statistical table showing results of treatment as noted according to schema shown in Figure 1. It may be observed that in much the larger proportion of cases the treatment was noted as palliatively good to fairly good. The method of radium treatment of carcinoma of esophagus may on the whole be considered a successful palliative procedure. We are inclined to rate it a definite advance over gastrostomy as a palliative measure.

The diagnosis was established by clinical methods and the *x*-ray, supplemented in a few cases by esophagoscopy. It is doubtful whether there were any errors as suggested by the subsequent course of the disease—amenableness to radium therapy, all too few autopsies and occasionally operation when gastrostomy had to be performed and where the lesion demonstrably involved the abdominal esophagus.

The possibility of metastases being present was not taken into consideration and no particular diagnostic search was made for them, because their detection would not contraindicate the use of a method as yet essentially palliative, and consequently indicated whether secondary growths were present or not. It is unique that metastases seem to occur late in carcinoma of the esophagus. In the two of our cases that lived the longest, there were no secondary growths found on complete autopsy.

TABLE III

STATISTICAL TABLE OF INCIDENCE, LOCATION, AND CONDITION OF LESION

		R	B	M	L	S	Z	H	C	B	H	P	H	S	B	T	H	P	K	H	U	C	S	B	S	H	R	S	C	L	K	D	M	B	R	M	B	W	C	E	H	C	F	S	F	TOTALS
SEX	Male	+	+	+	+	+		+	+	+		+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	40
	Female						+				+					+																			+											4
AGE INCIDENCE	4th decade	+									+	+							+						+					+		+								+		+	+			10
	5th decade		+	+		+				+			+	+		+		+				+	+			+	+		+		+		+	+		+		+			+					19
	6th decade						+	+	+								+			+				+											+		+		+					+	+	11
	7th decade				+										+						+																									3
	8th decade																											+																		1
LOCATION OF LESION	Upper 1/3																+	+				+	+				+			+					+	+				+	+					10
	Middle 1/3							+		+				+																		+										+	+	+	+	8
	Lower 1/3		+	+	+		+				+		+							+	+			+	+			+	+		+			+				+								15
	Abdominal	+				+			+			+			+	+			+							+							+				+		+							11
STAGE OF LESION	Advanced					+							+	+															+		+										+	+				7
	Moderately advanced	+	+		+		+	+		+	+						+	+				+				+		+				+														13
	Somewhat advanced														+				+		+		+		+								+	+		+			+				+		+	11
	Fairly early			+					+			+															+			+					+			+								7
	Early															+				+				+													+			+				+		6
DEGREE OF OBSTRUCTION	Totally obstructed												+	+																																2
	Markedly obstructed	+			+		+	+										+													+										+	+				8
	Moderately obstructed		+	+		+					+	+							+			+	+						+							+		+	+				+	+	+	15
	Slightly obstructed								+	+					+	+	+			+	+			+	+	+	+	+		+		+	+	+	+		+			+						19
	Non obstructed																																													

Fig. 4. A self-explanatory statistical table indicating incidence as to sex, age, location of lesion, stage of advance, and degree of obstruction. It is interesting that the great preponderance of cases occur in males, chiefly in the fifth decade, and in somewhat less measure the fourth and sixth, that all portions of the esophagus are nearly equally affected, that most cases presenting themselves for treatment are but moderately early, that the larger percentage of cases are moderately obstructive, and that total obstruction is not common.

Naturally one of your chief interests will center on the question of technique. This may be divided, first, into matter that pertains to the method of application and secondly, dosage. The technique of application is not easy, a matter of careful detail and difficult to express in words. The applicator used is simple, almost crude, and consists of an ordinary brass radium-bearing terminal mounted on a heavy, square, drawn silver wire having a considerable alloy; stiff enough to hold any angle at which it may be found necessary to deflect the terminal in order to canalize a given stricture, and not twist when rotated in the esophagus. It should not be so stiff that it will not readily take the upper pharyngeal and mouth curves, and so cause irritation. Over the wire is drawn a rubber tube of rather heavy wall and fine lumen, so that it may snugly fit the wire carrier, and of the same external diameter as that of the terminal container. Over the radium-containing capsule with its filters is drawn and cemented a rubber stall, the kind used being a portion of a fountain-pen bladder. Others have written of more elaborate apparatus, but the one described is designed primarily to be utilized under *x*-ray control and has been especially planned to effect accurate canalization of the carcinomatous stricture, and maintain such position. It also has the advantage of easy withdrawal by a nurse or other attendant in case the patient gets into difficulty. It is somewhat trying to the patient, though very few of our cases have failed to tolerate it. It has had to be withdrawn but 8 times in 125 applications.

A preliminary hypodermic of a quarter of a grain of morphine is given at least a half-hour before the treatment is begun. This is of the greatest importance, and to a large degree makes the whole procedure possible. In case the patient becomes restless or nervous during the treatment, a second smaller dose may be necessary.

Before the applicator is introduced, it is of the greatest importance to have an entire familiarity with the individual lesion through previous screen and plate studies. The stricture should be observed in both right and left lateral poses with the patient standing, and its direction in each determined, thus enabling one to form a mental picture of its direction in two 90-degree planes. Just a second before the introduction of the applicator the patient is given a mouthful of a barium mixture; either a water mixture or a stiffer medium according to the degree of obstruction, so that the stricture may be made fluoroscopically apparent during its canal-

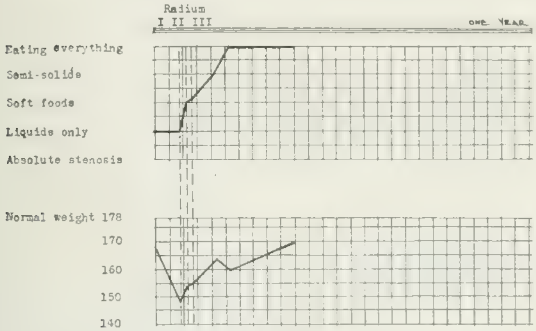


FIG. 5. A plotted curve graphically illustrating the result of radium treatment in carcinoma of the esophagus. In this case, though under observation but a short time, the palliative result has been strikingly good. The man eats everything and has returned to work. At present (July 26, 1922) the same good condition obtains six and a half months after the initial radium treatment. The patient is working and in the best of health. It took a week to learn to canalize this stricture in the abdominal esophagus. The patient was apparently within weeks of death from starvation and general depression. The case illustrates the more recent method of using three radium treatments in rapid succession: i.e., at intervals of three days, which we have learned to regard as the most effective procedure. The final palliative result is rated as good. It is conceivable that it may result in a cure.

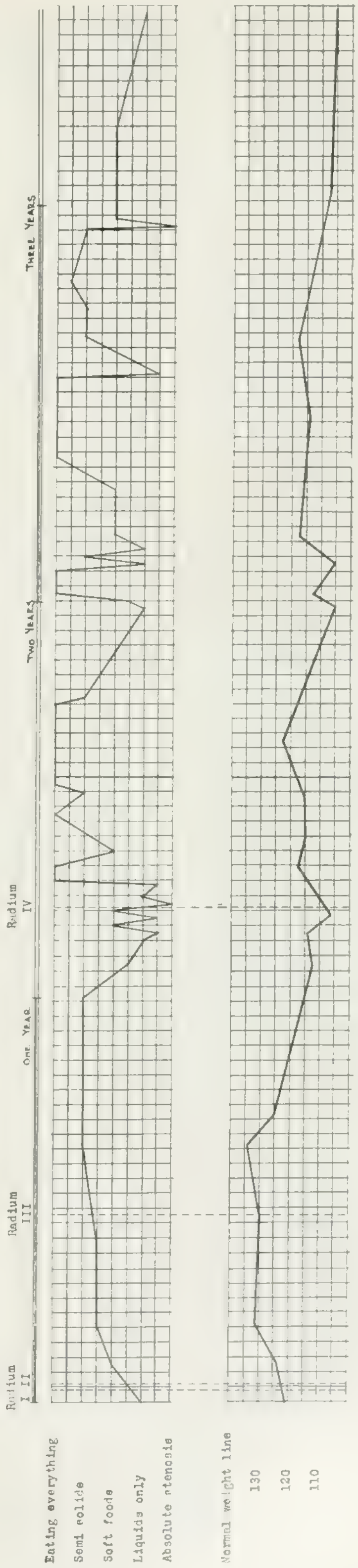


FIG. 6 Graphic curve illustrating the results of radium treatment in a case which lived three and a half years after the initial treatment. Death finally from pulmonary tuberculosis (autopsy). Lesion in abdominal esophagus, a mass of sclerotic tissue, had extended downward until it formed a carcinomatous collar about the cardia. It could possibly have been controlled there by radium treatments, had it been diagnosed in life. The immediate effect of each radium treatment is shown by the curve. The final result is rated as palliatively good.

ization by the radium terminal. In case the stricture is but slight and non-retentive, additional barium mixture may be fed by a spoon alongside the applicator, though this is not always successful. Another procedure in cases where there is but slight obstruction, is to mark on the skin of the body the proximal and distal levels of the stricture with the patient in a very carefully noted diagonal pose. The correct position of the applicator in the stricture will correspond to these marks when the patient is in exactly the same pose as controlled ortho-fluoroscopically. The feel of the applicator canalizing the stricture is of help. In the great majority of instances such procedure will not be necessary, as the stricture usually contains a sufficient thread of barium which, together with some retained in the proximal dilated esophagus above, will identify it.

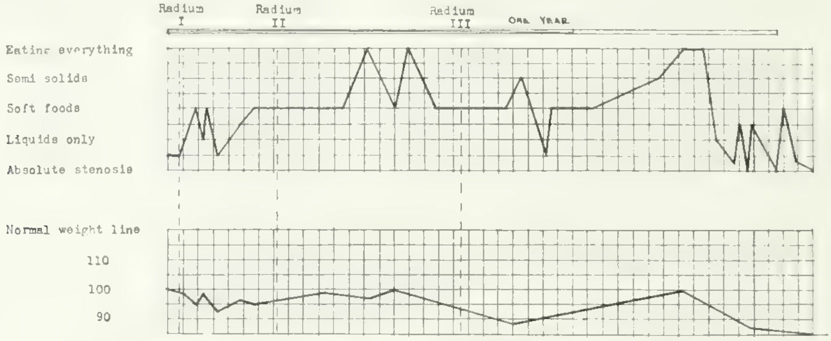


Fig. 7. A curve graphically illustrating the course of a case treated by radium after the original method, i.e., using radium on the recurrence of symptoms. Patient lived one year and seven months, dying finally of inanition resulting probably largely from secondary contracture. The final result is rated as palliatively fairly good.

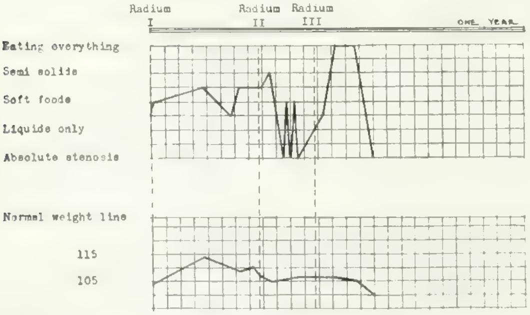


Fig. 8. A graphic record indicating the course of a case after radium treatment. The patient lived seven months after the initial treatment. The result is classified as but palliatively fairly good.

The applicator is prepared for introduction by carefully straightening the shaft and deflecting the terminal at an angle corresponding to that of the stricture in relation to the longitudinal axis of the esophagus above. The end of the applicator that is to extend out of the mouth is bent into a circular form whose plane will be exactly in that of the deflected radium terminal, so that it may give information as to the direction of the latter after the applicator is within the esophagus. In making the introduction the patient sits on a rather low stool, the operator standing behind him. The applicator is introduced

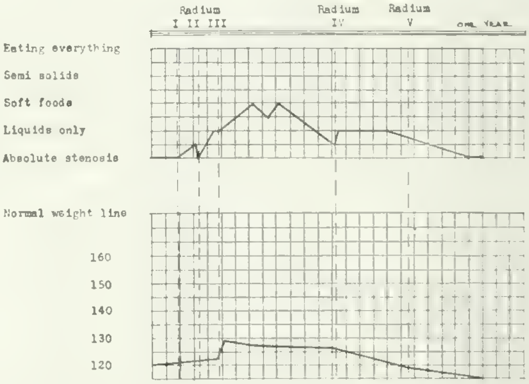


Fig. 9. A curve showing the results of radium treatment in a case in which the result is classified as palliatively fair. Case totally obstructed when first seen; a stretcher case. Esophagus opened by radium treatment so that the patient was able to eat soft food. The curve is influenced by the fact that a gastrostomy had to be done before the patient developed sufficient strength to undergo the radium treatment.

after the manner of an ordinary esophageal bougie, great care being taken to see that the patient's head is kept always back so that the esophagus and pharynx are as nearly in a straight line as possible, and to avoid bending the shaft of the applicator which would make a successful rotation of the terminal impossible. One of the greatest difficulties is to pass the pharyngeal esophagus with the radium-bearing terminal of the applicator deflected at as marked an angle as is often necessary, especially the case when the lesion is in the abdominal esophagus. Various tricks are of use almost impossible to describe. After the applicator has reached the lowest levels of the dilated esophagus, the patient is made to stand, carefully keeping the head extended, and is guided behind the fluoroscopic screen. When properly placed, usually in the right lateral pose, an effort is made to canalize the stricture by manipulating the portion of the applicator projecting from the mouth, at the same time observing the procedure fluoroscopically, the circle-like form into which this portion was bent before the introduction, aiding greatly. If the terminal does not immediately engage the stricture, which is usually the case, the applicator may be rotated outside the mouth until it is tricked or jumped into the opening of the stricture, keeping in mind the essential individual two-planed plan of that particular stricture. The fluoroscope gives a vivid idea of how easy it would be to perforate the esophagus, were the terminal not exactly engaged in the stricture and external pressure exerted. An anteroposterior view, or a left lateral rotation of the patient, is helpful. The whole procedure is somewhat after the manner of the catheterization of the Eustachian tube, though with the advantage of being visible and the disadvantage that the procedure will never be the same in any two cases. When the applicator is in place, it is fixed in position by a narrow bandage arranged in bridle fashion about the patient's head and neck. After it is thus fixed in position, the patient with head extended, is led to another room where a suitable reclining-chair with head-rest has been prepared for him to sit in during the period of treatment. The head-rest is arranged so that the head is kept always extended; this on account of the danger of injury through movements of the head, and that the shaft may be kept in an approximately straight line, so that further manipulations during the course of the treatment are possible if they become necessary. The position of the terminal can be checked fluoroscopically a few times during the treatment. In instances of a lengthy stricture the bridle bandage can be readjusted so that the terminal will extend slightly lower into the stricture for the second half of the treatment, in order to irradiate all portions of it. At the end of the six-hour period the applicator is withdrawn after a final fluoroscopic observation as to its position. The presence of any blood on it should be noted.

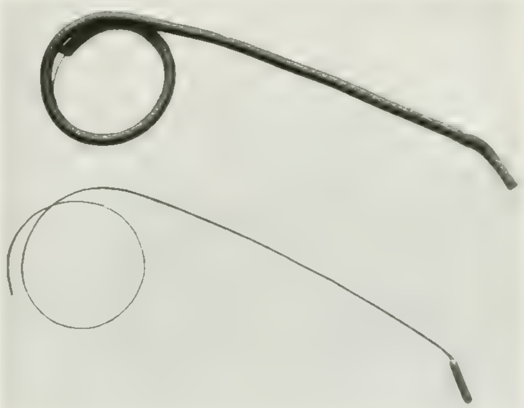


FIG. 10. Above, the applicator as ready for use, the wire shaft covered with rubber tubing, rubber stall cemented over terminal. The terminal is shown bent at an obtuse angle as though for the canalization of a given carcinomatous stricture in which exactly such deflection is necessary.

Below, the metal terminal and wire carrier. The proximal portion of the applicator is shown bent in spiral form as ready for use. The plane of such spiral, being in exactly that of the deflected terminal, indicates its direction when in the esophagus.

A careful and detailed record is kept of every stage of the application, and a final note made as to the exact technique that was successful in that particular case; especially a description of the different directions and rotations necessary to canalize the stricture. Often a tracing of the deflection of the terminal and sketches are helpful. In our series in no case did we fail to canalize the stricture, though in certain instances it has taken efforts on several successive days, and as long as a week to accomplish this finally, through gradually accumulated experience with that particular case. In no instance was injury done. One must pause to imagine what doubtless happened in the old days of blind esophageal instrumentation; we doubt not that many a perforation occurred which was not reported in the literature. The earliest case of carcinoma of the esophagus that we have ever seen, as shown by autopsy, was perforated by a practitioner with an ordinary bougie.

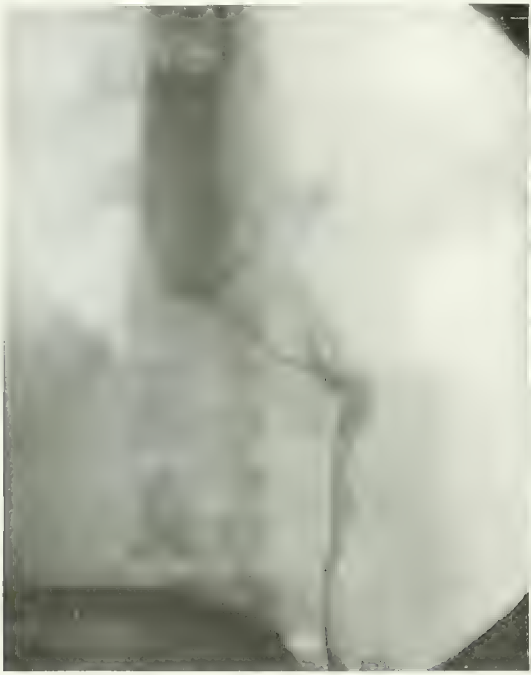


FIG. 11. Showing a characteristic carcinoma of the very lower thoracic and abdominal esophagus, a common form, difficult of canalization on account of the degree of angulation of the thoracic esophagus. Compare with the following illustration indicating the method of canalization by the deflected radium terminal.

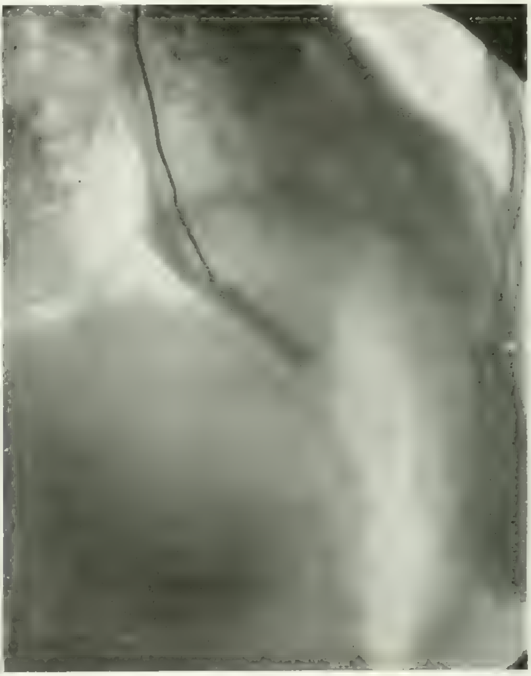


FIG. 12. Showing the marked deflection of the radium terminal necessary to canalize a given carcinomatous stricture of the abdominal esophagus. Compare with the preceding figure.

Modifications of the technique may be necessary to suit the individual case. Thus, at times the stricture is so narrow that certain filters must be omitted to effect canalization. In certain instances the applicator must be mounted in a small colon tube or large catheter to effect the canalization of the abdominal esophagus on account of its abrupt curve. If this is necessary, it is best to anchor the radium 1 in. from the tip of the tube, the tip acting as a guide. In 2 cases the carcinomatous stricture was canalized when there had been absolute obstruction for more than a week. This was effected by finding a sort of cleavage point and gradually working the terminal into it. In certain strictures, only the proximal portion can at first be canalized, but it has been found that if the radium be left so emplaced, in a few hours, it will gradually work deeper, either as a result of gentle pressure by the terminal or shrinkage through the action of the radium; perhaps both.

In all probability the means described can be improved upon, but it has been found reasonably effective, and is the product of actual experience.

TECHNIQUE OF DOSAGE

It is obvious that certain principles as to dosage are applicable in carcinoma of the esophagus. It is equally obvious that there are restrictions as to the means and manner of irradiation on account of the position and physical peculiarities of the tumor. It is evident that distance filtration is not possible, and that intimacy of contact is possible. Peripheral secondary supportive irradiation is impossible; the tumor can be irradiated only centrally. Radiation by emanation needles is hardly feasible, though it might be attempted under esophagoscopic control, and is not appropriate on account of the danger of perforation and deep slough with the resulting possibility of secondary perforation. On the other hand, a certain amount of superficial slough within the lumen of the esophagus may be of benefit, through affording relief of the obstruction.

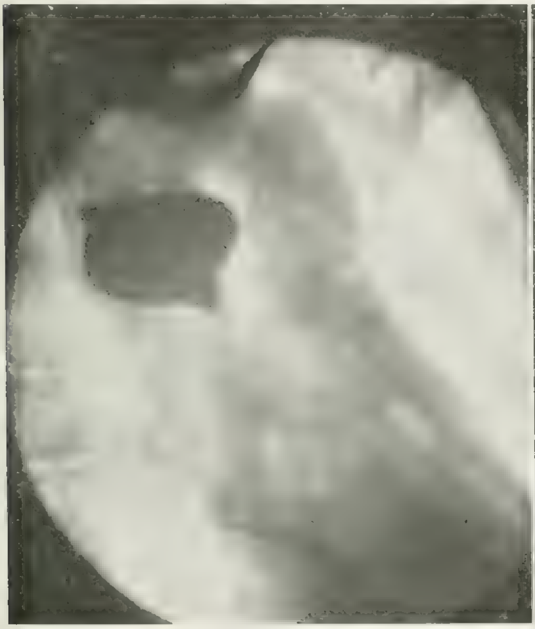


FIG. 13. Illustrating stasis proximal to a totally obstructive carcinoma of the esophagus. Plate two days after initial barium ingestion. Stretcher case. Patient unable to swallow even water for one week previous to initial observation. Compare with two following figures which show the method of canalization of such a lesion (Fig. 14) and the result (Fig. 15).

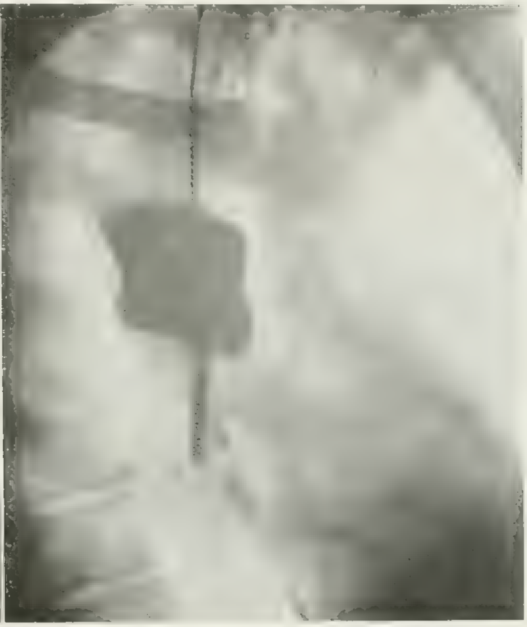


FIG. 14. The canalization of a previously totally obstructive carcinomatous stricture of the esophagus. (See preceding figure.) The illustration was made during the third radium treatment after the total obstructive stricture had become patent to a slight degree. The danger of the blind method without control by the *x*-ray is suggested, as it will be noted that the radium terminal is not in the axis of the esophagus, and a perforation might occur. In this instance the terminal was driven into a totally obstructing carcinomatous mass after finding a sort of line of cleavage, with the result that the total obstruction was relieved. (See following figure.)

DOSE

The dose should be as large as can be tolerated by normally local tissue with fair safety. It should be applied to all portions of the tumor, but maximally to those portions that are probably or can be actually determined by *x*-ray plates to be thickest. Naturally these areas will usually be the median zones of the tumor. In lengthy strictures, which are not very common, it may be best to irradiate first the upper portion, then the lower. The two positions thus taken by the applicator will usually overlap in the median thicker zones of the tumor, effecting its more intensive local irradiation. As a matter of fact, this end will generally be effected automatically, as if placed in the higher levels of the stricture initially the terminal will gradually sink lower during the treatment as the result of the pressure and the adjustment of the applicator to the esophageal curves, or perhaps through actual shrinkage of tissue due to the action of the radium. During the latter stages of the treatment it may be necessary to elevate again the terminal to the upper reaches of the stricture.

As to the dosage itself, we have taken the position that it was best to use a dose well within the bounds of safety; and the majority of our cases have, with this idea, been treated with a dose that we must now regard as not only entirely safe, but as inadequate to the demands of the situation. Consequently of late we have been treating cases with a considerably heavier dosage. The smaller original dose was 50 mgm. of radium element left *in situ* for six hrs.—300 mgm. hrs. Our later plan has been to use the same dose but repeat it every third day for three times, totaling 900 mgm. hrs. We have considered these three successive applications as amounting to a single dose as they occur well within the period of cellular reactive change. Since results have been rather strikingly better since using this larger dose, and especially since no untoward results have occurred, we feel that a still larger dose may be attempted in the future, and anticipate using next, 1,200 mgm. hrs.; in our opinion probably a safe procedure with the same filtration as that used in all treatments, namely, ½ mm. of German silver, 1 mm. of brass and a thickness of rubber. We also anticipate that in certain more extensive tumors a larger amount of radium, probably 75 mgm. can be used to advantage, on account of the fact that it is doubtful whether the smaller dose effectively irradiates the entire lesion. It has the considerable disadvantage of being more bulky.

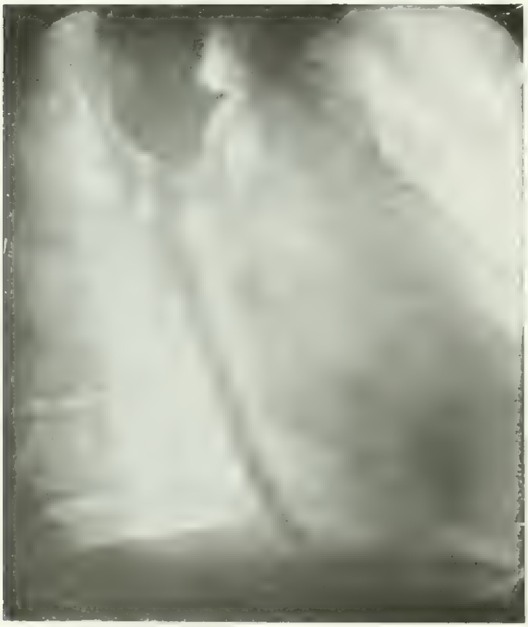


Fig. 15. Formerly totally obstructive stricture of the esophagus opened by radium treatment in definite degree. Plate, taken three days after third treatment, shows definite canalization by barium. Patient able to take soft foods and resume work for a time as salesman in a furniture store. (See two preceding figures.)

Our original plan was to treat initially with the dose mentioned, 300 mgm. hrs., repeating this on the recurrence of unfavorable symptoms, if necessary a number of times. Feeling that there is just a possibility of developing a radical cure of the disease, given early diagnosis, and hoping thus to prevent secondary sclerosis with late contractural stenosis, we have concluded that the treatment must be as maximally massive as safety will permit. To repeat; as far as we have tried heavier dosage, the results are distinctly more palliatively favorable than with the smaller dose.

Radium Treatment No. 2

9 a.m. Hypodermic injection of 1/4 gr. of morphine and 1/150 gr. of atropine.

10 a.m. Introduction of 50 mg. of radium mounted on ordinary applicator, filtered with rubber, brass, and silver.
Introduction most difficult, i.e., difficult to pass pharynx with adequate angulation, and more difficult to canalize full depth of stricture.
Technical. Terminal deflected rather markedly in one plane and slightly laterally in right angle plane (90°). Need really more angulation than was possible on account of double right angulated course of lower stricture (seen with patient in left lateral position).
Radium left nearly imbedded in upper half of stricture but not canalizing "double angle" (did canalize at initial treatment).
See Sketch.

11 a.m. Radium as last emplaced.

2 p.m. Radium slightly higher than as last emplaced. Replaced slightly lower level in "false pocket."

4 p.m. As last emplaced. Removed. No blood. Patient in good shape.

Fig. 16. Page from detailed notes showing method of recording data pertaining to radium treatments with special reference to the technique necessary in the individual case. (See two succeeding illustrations.)

CONCLUSIONS

We may state our conclusions as to the results of the treatment of the cases reported. Rather elaborate notes have been kept and an effort made to keep in touch with all patients, noting the general outcome and clinical course of the disease. But 4 patients were lost track of.

It is difficult to form an estimate as to the benefit of the treatment because of different initial conditions. No case was refused treatment. Most of the cases were lamentably late, some were totally obstructed, some gastrostomized, some stretcher cases, and pitifully none were what could be considered very early. Apropos we might make a hard arraignment of those who first see these cases, give medicine, temporize, and hope until the condition becomes advanced, without attempting to make a diagnosis. A still more depressing view is that many, even most of the patients themselves, being nervously sound and usually in good health otherwise, do not seek aid for sometime after the onset of difficulty in swallowing certain foods, and until they have attempted various home methods of relief. In order to diagnose these cases early, and thus afford them better help, an educational propaganda is needed after the fashion of that conducted in the instances of pulmonary tuberculosis, cancer of the breast, uterus and so on, but more difficult because of the comparative rarity of the disease.

As previously stated we have seen no case that would indicate that a cure had been effected, nor do we believe that in our series any case will probably result in a cure. This in itself is naturally discouraging. On the other hand it may be emphasized that we have made but a beginning. As in *x*-ray therapy, certain discouraging phases must be passed through. We are at present accumulating knowledge and experience on which we may modify, reconstruct and build our methods of the future. It is encouraging that cancer of the esophagus shows a definite amenability to a degree to radium therapy. The principles are obvious. Even in our small series, and with but a very restricted variation as to dose, we have obtained much better palliative results

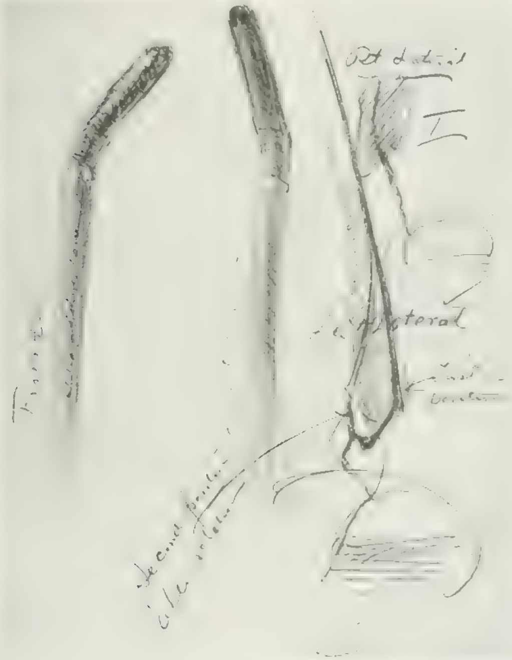


Fig. 17. Page from original notes showing sketches illustrating exact degree of deflection of radium terminal and manner of manipulation necessary to canalize the stricture in a given case. (See preceding figure, same case.)

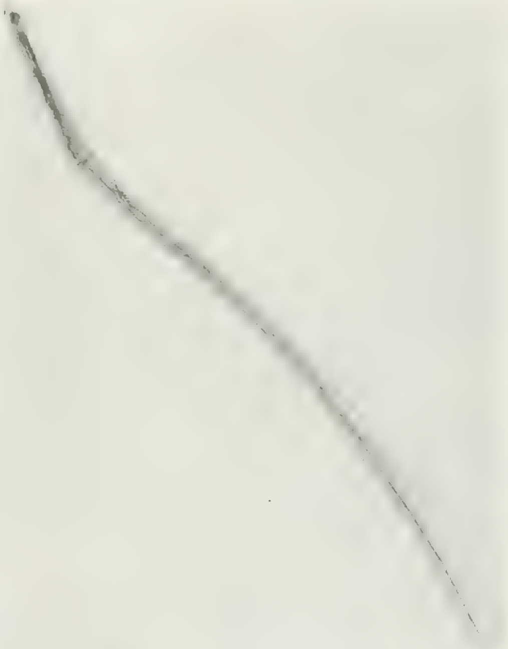


Fig. 18. Page from original notes. Sketch made from tracing of applicator showing exact degree of deflection of terminal and shaft necessary to canalize a given stricture. Such information thus readily available for future treatments. (See two preceding illustrations, same case.)

of late than we did at first, and we now anticipate good palliative results with a considerable degree of confidence. We must regard the treatment as a successful palliative measure. It unquestionably prolongs life and lessens the agony of starvation and thirst.

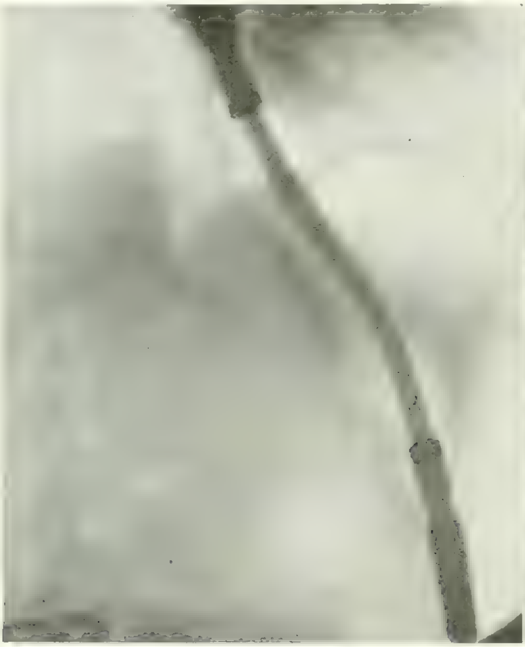


Fig. 19. A specially constructed cardiospasm dilator *in situ* divulsing a "cardiospasm." Illustration to show that the method of *x*-ray control is very applicable in other esophageal instrumentations. The dilator contains bismuth in the tip and is provided with lead ring markers. The divulsion of cardiospasm by such an apparatus is a revelation as to what occurs and what must not have occurred by the old blind method. It has been found that the divulsing balloon is best used smaller than as in the older dilators. (See following figure.)

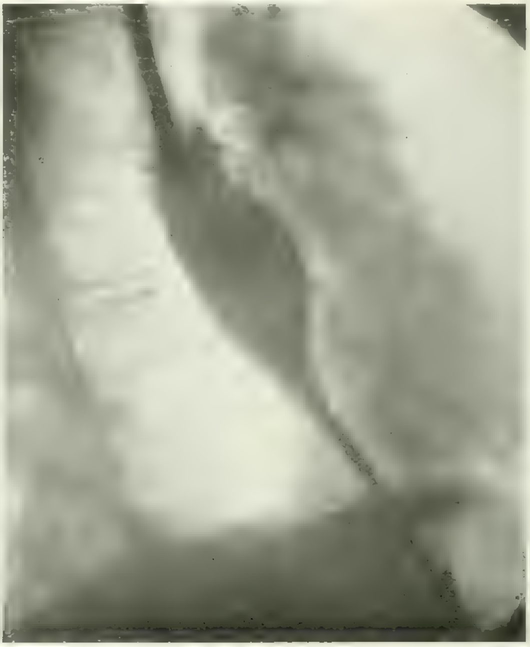


Fig. 20. To illustrate another outlet for *x*-ray control of esophageal instrumentation. The divulsion by a bougie of a stricture of the esophagus, here probably largely the result of the radium treatment of a carcinoma, by an ordinary silk gutta-percha bougie loaded with bismuth.

In our series of 44 cases, the palliative result was strikingly good in 12; in an additional 12, it may be summarized as fairly good; in 14, fair; in 3, fair only, and in 3 others it was considered negative. Thirty-four cases have died; 10 are still living and under observation. The length of life after treatment varies exceedingly, in general, in proportion to the stage and severity of the disease. It seems possible also that it may vary according to the histological character of the lesion. Curiously, there seems little relation between the time that the disease had existed before treatment and the length of life thereafter. This is probably only apparent and indicates the period during which the symptom-provoking obstruction has existed. The longest duration of life after treatment was three and a half years. In this instance an autopsy indicated that death was not due to the lesion directly. The original site of the carcinoma in the lower thoracic esophagus was a mass of scar tissue in which were caught carcinomatous cells. The disease had extended down the abdominal esophagus and formed a small cancerous collar about the cardia. It could possibly have been controlled here, had this been determined to have been the case during life. Most interestingly the lesion was histologically an epithelioma, common in the esophagus but exceedingly rare in the stomach, especially the fundus of the stomach, and thus strongly suggesting that there had been an extension from an original esophageal lesion. Another case lived two years and four months; another, a year and seven months; the remainder of those not living died within a year. When one recalls that cancer of the esophagus kills with almost unprecedented rapidity it cannot but be considered that the treatment lengthened life appreciably. In all but 3 cases there was relief of dysphagia—in certain of these very striking. Patients scarcely able to take water, and that not in adequate amounts, were able, after treatment to take a liberal soft diet; and in certain recent more heavily treated cases the patients can eat everything, including such foods as cabbage and dried herring. Of these latter favorable cases, a few regained nearly former weight, returned to work and are still working. One man who was within weeks of death three months ago is walking twelve miles a day as an inspector.

The treatment has resulted as is often the case in similar endeavors, in the development of unforeseen difficulties. Thus the problem of secondary sclerotic stenosis, that must be dealt with as a benign stricture requiring bouginage, is a real difficulty.

The occurrence of pain, thoracic in general, or of curious reflection to pectoral or other regions, even the jaws and teeth, is an unfortunate secondary development that we have learned to regard as an ill-omen, and probably indicates the peripheral extension of the lesion with involvement of nerve tracts. This pain has a most unfavorable influence in lowering the general condition and morale of the patient. Ordinarily such pain is not seen in cancer of the esophagus, because patients do not live long enough to develop it. Secondary intermittent spasm at the site of the stenosing stricture caused much distress in certain cases.

DISCUSSION

Dr. Kimbrough. There are only one or two points to which I wish to call attention. First, every patient has received immediate relief. I do not think the immediate relief was entirely due to the radium, but partly to the effect of the bougie and instrumentation, although I do think that the radium has enabled the structure to remain open. The first essential in these cases is to know the location and extent of the tumors. The next is the dosage. From the specimen we were fortunate enough to obtain after the post-mortem, we found the entire tumor growth had been destroyed. Now if that is true, we can hope for better results if we can use enough radium to destroy the entire cancer growth. All the patients have been benefited, but the statistics show that only 10 are alive. Our results, therefore, have only been palliative. How can we improve these? I believe we will get better results by increasing the dosage. We were giving 50 mgm. for six hrs., and repeating this in six weeks. I think a larger dose, say 75 mgm. repeated every three days until they have three or four doses, would give better results.

Dr. Quigley. Within the last few years, we have found out a good deal about cancer of the esophagus, because we have given it more attention. It was formerly considered incurable, and not much attention was paid to it. Cancer of the esophagus constitutes about 9 per cent of the cancer deaths in America, England and Wales, and other countries from which we get statistics. Any disease with such a large percentage of deaths should be of great interest.

Another thing of interest is that on post-mortem, we find in these cases of cancer of the esophagus, that the patients nearly always succumb because of a mechanical effect. The patient starves to death because the esophagus is shut off. The small percentage, about 5 per cent, that are of the glandular type, are untreatable and incurable. We do not need to consider them. Those grave ones start at the bifurcation or at the cardia opening, and they usually remain for a long time localized in one particular spot. They do not metastasize early, so if radium is applied early in the disease and applied properly, these things should be curable, and I hope to see in the future that they are.

One other point that I wish to call to your attention, which I consider of great importance, is this: In looking up the registration statistics, in the United States, England and Wales, we find one symptom outstanding in the making of early diagnoses in these cases, and this one symptom is usually overlooked by the doctor to whom the patient goes for relief. That is, the difficulty in swallowing. Patients complain of pain and of coughing up blood, but in the early stage they complain of the dysphagia, or difficulty in swallowing. If we investigate with the *x*-ray everything of this nature that comes to the office of the general practitioner we will get a lot of these cases early enough and localized enough so that we can get many more cures.

We use the Sippy instrument in treatment of these cases. We dilate them first by a 44 or 48 bougie, and then, after we dilate them, we put the radium tube at the shoulder of the largest bougie, then introduce the Sippy bougies down along the piano wire so that when withdrawn a short distance, we have the radium tube right in the narrow space. We have had good results in treating these growths in this way.

Dr. Stone. I think the doctor is to be congratulated on the efforts he has made. I have observed the work which was begun by Dr. Janeway and followed recently by Dr. Quick, and the results have so far been discouraging. The difficulty of getting these cases early appears to depend upon the peculiar anatomy of the esophagus. The mucosa is extremely thin and delicate, and the growth, instead of spreading by direct continuity of mucous membrane, penetrates deeply, and then spreads beneath the mucosa, so that often another lesion may appear several inches away from the original site. I am afraid that most of the immediate results that have been obtained have been due to the stretching of the growth during the manipulation of the treatment. Primary perforation from this manipulation may be prevented, but subsequent perforation may result from the necrosis which the radium has produced—occurring sometimes five or six weeks after treatment has been applied.

Dr. Hanford. I was much interested in the technique given by the essayist. I have eliminated the introduction of the metal guide. It is continuously irritating, and the patient is continually gagging. There was a time when I employed whalebone to introduce radium to the site of the lesion. Also soft silver wires had their day, but they were very distressing to the patient and have been discontinued. I also use the piano wire, to commence the dilation. In the first step I have the patient swallow silk twist, letter D or E. This should be anchored in the intestine in twenty-four hrs., and will act as guide for the piano wire as well as the radium carrier. It is understood that the stricture has been located before dilation is attempted. The silk twist is now threaded through the cone-shaped end on the piano wire and the latter is passed down the silk thread till the end is in the stomach. At this point the olivary bodies are threaded on to the piano wire until the patient is able to take a No. 41. These are pushed down through the stricture, after which the piano wire, together with the olivary bodies, is removed. The string is still retained as the guide for the carrier. My carrier is very simple. It consists of a metal barrel (brass) 3 cm. long, 8 mm. outside diameter, 1 mm. wall thickness. On the distal end is a cone-shaped body about 1 cm. long, and on the end of this is a hollow spiral wire 7 cm. long. There is an opening on the side of this spiral wire near where it joins the main portion of the carrier. The silk twist, which is acting as our guide, is threaded through this spiral wire. On the proximal end of the barrel of the carrier is a screw cap, in the head of which is a hole where the end of my spiral wire pusher loosely fits. There is also a small hole through this cap where the heavy silk cord is threaded, by which the carrier is removed after irradiation. In introducing, the assistant holds the silk twist guide taut, and the carrier is made to slide down the twist by means of the pusher. The heavy removal cord is held tight, so that the pusher will not be dislodged, in its passage down. The patient is all this time behind the fluoroscope. When the barrel of the carrier is at the point of stricture, which has already been located by a coin on the chest wall, when the patient was swallowing the bismuth, the pusher is removed, leaving the carrier in position. The removal cord is fastened to the cheek by adhesive tape. If there is any fear that the patient may bite through the string, the latter can be fastened to a tooth. Two mm. wall thickness rubber tubing is slipped over the barrel, to absorb the secondary rays. The carrier may remain in position for twenty-four hrs. without discomfort to the patient.

My dosage is larger than when I gave my preliminary report, and by this increase I find our results are better. I now give 600 to 800 mgm. hrs at the first application, and repeat this in a week, after which the patient rests for three weeks.

In closing, I wish to relate that one case that gave a perfect picture of carcinoma of the esophagus, and was benefited by radium, showed, at necropsy, tuberculosis, but no carcinoma.

Dr. Mills (closing discussion). Most of the points that were mentioned in the discussion we tried to review in the paper. Dr. Quigley stated that carcinoma of the esophagus accounted for 9 per cent of all cancer deaths. This is surprising to me, when we recall the cancer incidence in other organs. I had always regarded cancer of the esophagus as rather rare. With reference to the method of esophagoscopic control versus the fluoroscope; it would be very difficult for me to accept any sort of method of blind instrumentation. I used the Sippy method of stricture instrumentation before we used the *x*-ray as a means of control, and I cannot help feeling that the method that affords the opportunity to see what one is doing has a marked advantage over the other in which one does not. The use of the wire radium applicator in the throat is difficult but with the aid of morphine many of these patients have little distress and often slumber through the treatment. At any rate they are not a class of patients who are very particular when they are starving and see a chance for relief. They will submit to anything. Again, if a method jeopardizes accuracy of getting into the stricture, or any portion of it, I must select another that does not.

In our series of cases only one perforated at a time and in a way that suggested that this might have been the result of the radium treatment. Others perforated late, some weeks or months after the treatment; in one case two months, but not at such a time as would lead to the conjecture that it was other than incidental.

THE TREATMENT OF SUPERFICIAL CANCER, WITH STATISTICS AND TECHNIQUE*

BY D. T. QUIGLEY, M.D., F.A.C.S.

OMAHA, NEBRASKA

THE cases recorded here number 593. This number we have been able to trace over periods of from two to seven years. In this group we have included cases of cancer of basal-cell, gland-cell and squamous-cell type, and also the melanotic tumors—the so-called melanosarcomata, which are really melano-epitheliomata.

The superficial type of malignancy was chosen for this paper because this type is the most easily treated and studied, and in the matter of treatment, if we have anything of real value to offer, it should show at its best here. Another consideration is that if we have a remedy that really works well in superficial, localized cancer, then we are close to having the key to the whole situation, because every cancer passes through a stage when it is localized, and nearly every localized cancer can, by proper surgical methods, be made superficial or accessible.

Of face cases in this group, we have had 146, and of these, six were of the melanotic type, growing from moles and showing evidences of malignancy in rapid growth or ulceration. Some of these were quite large, one being 1½ in. in diameter, and another, having been scattered by several operations, was irregularly distributed over an area about 2 in. square. All of these melanotic cases were cured. Of the basal-cell and squamous-cell varieties, about ten per cent failed to heal. Among the failures, some were in patients of low vitality, and some in patients in whom the disease was so extensive that the treatment was undertaken without hope of cure, but to afford temporary relief. In the cases that at once healed completely, recurrences were very few. For such recurrence, five per cent were subjected to second applications, and about two per cent of the cured cases were subjected to a third treatment.

Of lip cancer, we have had 171 cases. Many enlarged glands, or considerable growth in few glands, means death for the patient in practically every case, but localization of the growth just as surely means cure if the patient is properly treated. Lip cancer remains local for a much longer time than we have been led to believe. Of our lip group we have had 19 or about 10 per cent of failures to heal.

Cancer of the eyelids presents a particularly interesting group because these cases do not, for anatomical reasons, lend themselves readily to operation, and if they are operated on, they almost surely recur. The patient then finds himself with a larger and deeper epithelioma, and whether or not another operation is done, the disease eventually gets into the orbit, destroys the eye, and later destroys the patient's life. In the eyelid group we have had 99 cases. Of these, 2 were melanotic, and one was sarcoma of the upper lid. In this group we had 7 which failed to heal and one accidental burn of the cornea which did not heal.

Of cases involving the skin of the nose, we had 116, and of these, one was skin sarcoma and 2 were melanotic. These 3 cases healed promptly. Of the remainder, we had 7 which were not cured. Most of the nose cases were small epitheliomata, but a few covered quite a large surface area. We did not get complete or permanent healing in any nose case which invaded bone or cartilage.

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

Our ear cases are 22 in number, and of these, 5 failed to heal. The malignant disease invades the cartilage very early, and this tissue does not heal well. In some of the cases that involved cartilage, plastic work was necessary to remove the diseased edges of cartilage and cover with skin.

Of hand cases, we have had 14, of which 4 failed to heal. Malignancy on the back of the hand is prone to form metastasis early, as the area is massaged with every movement of the hand and it is exposed to light and trauma. The cases in which we failed were those in which the disease covered a large area, or in which metastasis had already developed in the axilla. One such case, in which we removed the arm and glands after a preliminary raying, is well after five years.

We have had 4 epitheliomas on the back that were severe enough to be dignified with the term malignant. Of these, 3 were melanotic and one squamous-cell. Two of the melanotic died. The other, which was small, and the squamous-cell epithelioma were cured.

Of scalp cases, we had 7, 3 of which were failures.

Of penis cases, we had 3. One died, and two had amputations following radium treatment. The two latter cases are apparently well.

Of Paget's disease of the nipple, we had 6 cases, of which 2 are dead and 4 apparently cured.

Of epithelioma of the navel, we have had 2 cases, and both are dead.

Of cases involving the fingers, we have had 3 cases, 2 of which are well, and one is well following an amputation.

Of the 593 cases, 68 failed to recover. Some of these deaths were due to a continuation of the etiology which caused the disease in the first place, and were really the development of new cancers from the same causes reproducing the same effects. This is true especially in cases of lip cancer, where the etiology has been bad teeth and tobacco. If the patient continues with these causes after his disease has been healed, it will almost certainly recur. The fact that he has grown cancer is proof that his tissues and blood furnish a good place for the disease to grow. If the local irritation is continued, there can be no other result but that the disease will reproduce itself.

Various kinds of pernicious meddling before coming for treatment doubtless account for some failures by stimulating deep extension and metastasis. In this class, rented radium may be mentioned, also radium in the hands of inexperienced persons who generally know little or nothing about the physics and chemistry of the element they are using, the pathology of cancer or the anatomy or physiology of the tissues in which it grows.

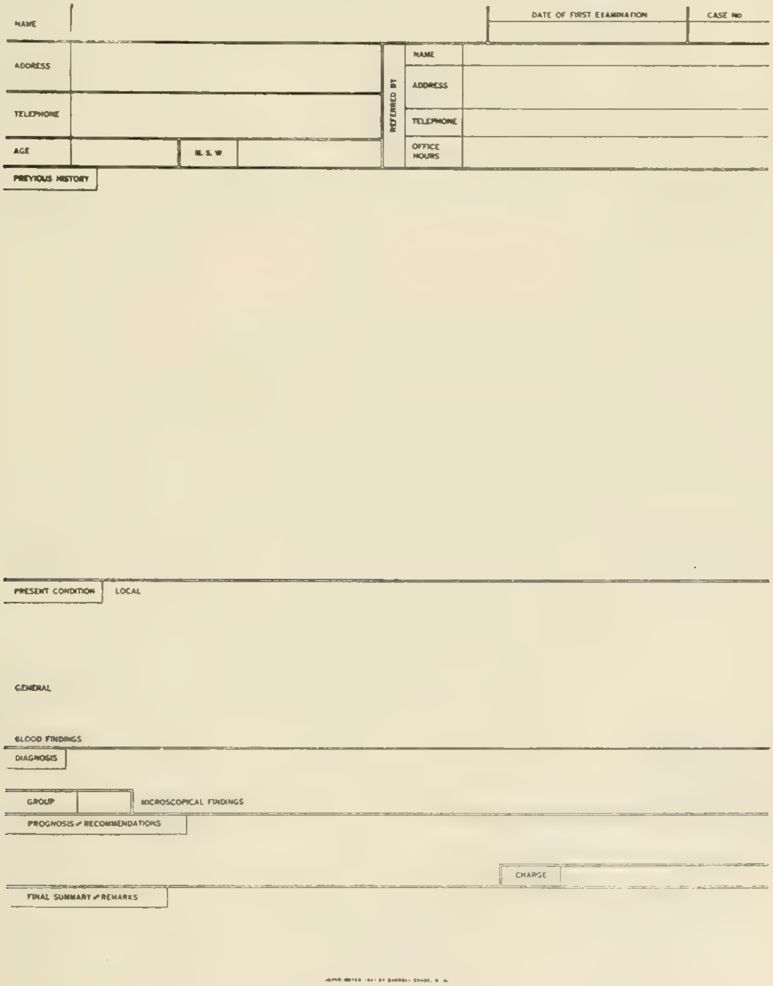
The instruments used were tubes and needles. The tubes were 15, 30 and 50 mgm. each; needles contained from 5 to 12½ mgm. each. In computing our dose we take into consideration the actual diseased area and about ¼ in. beyond. The tubes are arranged to cover this area, screened with ½ mm. silver and 1 mm. rubber, and kept in place by adhesive. The depth is estimated and the tubes left in place long enough to deliver double an erythema dose at the deepest part we wish to reach. We give large enough doses to destroy the disease absolutely, disregarding burns. In cases where the operation of the law of the light decreasing inversely as the square of the distance would prolong our treatment to too great an extent, we use needles directly in the diseased area. When this is done, the dose in milligrams can be reduced to from ⅓ to ¼ the amount used when the radium is applied externally, since when the radium is buried, 100 per cent of the radiation is effectual.

A HISTORY CHART FOR RADIUM THERAPY*

BY CARROLL CHASE, M.D.

BROOKLYN, NEW YORK

THE history chart here illustrated is the result of considerable experience in attempting to keep accurate records of radium therapy over a period of some years. It is printed from an electro on both sides of a heavy bond paper, known as ledger paper; this being chosen in preference to bristol board because it wears better, is more easily handled in the typewriter and takes up less room in filing. It is printed in red, as this makes a good contrast to the printing from the ordinary black typewriter ribbon. It is 11 × 8½ in. This size allows of vertical filing in the ordinary deep desk drawer. The charts are arranged alphabetically, though a further index of the cases may be made, if desired, according to the disease or condition.



NAME
DATE OF FIRST EXAMINATION
CASE NO
ADDRESS
TELEPHONE
AGE
M. S. W
REFERRED BY
NAME
ADDRESS
TELEPHONE
OFFICE HOURS
PREVIOUS HISTORY
PRESENT CONDITION
LOCAL
GENERAL
BLOOD FINDINGS
DIAGNOSIS
GROUP
MICROSCOPICAL FINDINGS
PROGNOSIS & RECOMMENDATIONS
CHARGE
FINAL SUMMARY & REMARKS

FIG. 1.

Although the chart speaks largely for itself, a few explanatory remarks may aid in understanding it. In filling out the top, the patient's name is given in full, and should she be married, her husband's name is also given. The items on the blank in regard to the telephone number and office hours of the physician referring the case will often save time when it is desired to report on the patient's progress or to get further information. The space for "Previous History" and "Present Condition, local and general" is large enough so that if small type is used, considerable detail may be given.

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

The grouping of cases follows that in the schedule submitted by the Research Committee of the American Radium Society in 1920, and is as follows:

A—Operable
B—Borderline or doubtfully operable
C—Inoperable
D—Advanced and hopeless
E—Recurrences, local or regional

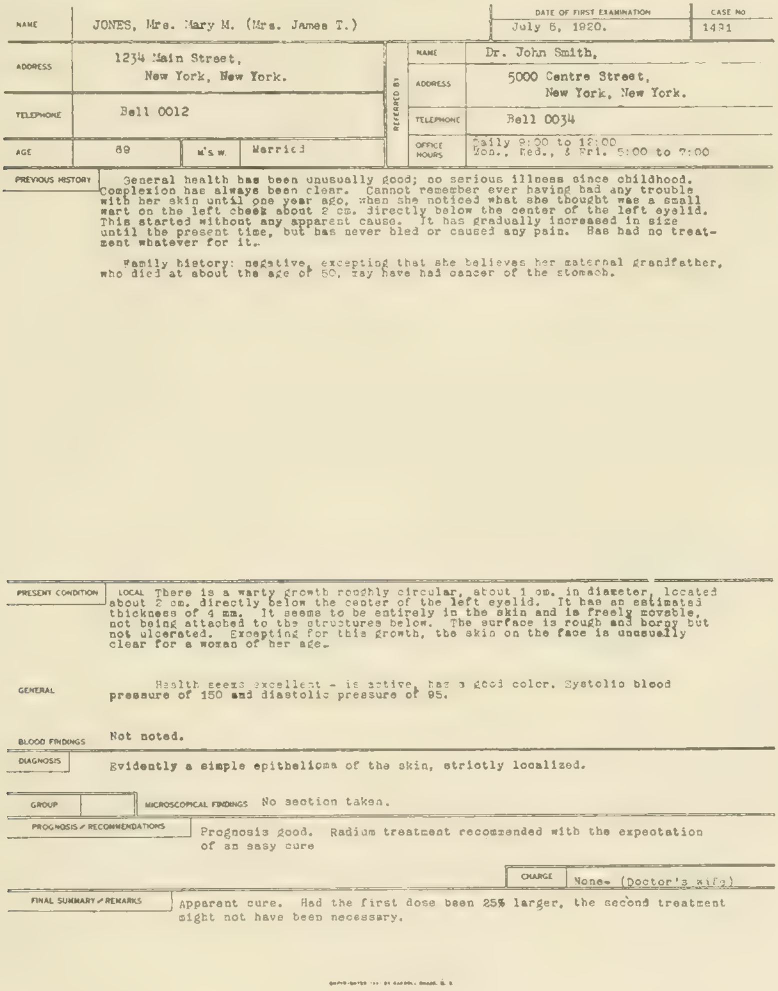
To this I have added one more group, F, of such special odd cases as do not easily fall into one of the five groups. The "Charge," perhaps, had best be noted on the chart in some simple code. The last space on the front page, headed, "Final Summary and Remarks" ordinarily is not filled out until the case is discharged. This has proved quite valuable in checking

DATE OF VISIT OR TREATMENT	MG. OR MC. USED	SCREENING	LOCATION AND DISTANCE	DURATION OF TREATMENT	MG OR MC HOURS

Fig. 2.

over cases for end results, and in studying technique.

The other side of the sheet is used as follows: If a treatment is given, the various columns are filled out as indicated and a line is drawn directly across the page under this. If more than one person is giving treatments, such entries should be initialed. If a visit without treatment is to be noted, it is typed in without any reference to the columns, and a similar line is drawn beneath it. Telephone reports of the patient's condition are also recorded here. By thus noting treatments and incidental visits in chronological order, the history is rather more easy to follow. Follow-up reports at definite intervals should be obtained from many cases and may be typed on the chart exactly as are treatments or incidental visits.



NAME JONES, Mrs. Mary M. (Mrs. James T.)
DATE OF FIRST EXAMINATION July 6, 1920.
CASE NO 1431
ADDRESS 1234 Main Street,
New York, New York.
TELEPHONE Bell 0012
AGE 69
M.S.W. Married

REFERRED BY
NAME Dr. John Smith,
ADDRESS 5000 Centre Street,
New York, New York.
TELEPHONE Bell 0034
OFFICE HOURS Daily 9:00 to 12:00
Mon., Wed., & Fri. 5:00 to 7:00

PREVIOUS HISTORY General health has been unusually good; no serious illness since childhood. Complexion has always been clear. Cannot remember ever having had any trouble with her skin until one year ago, when she noticed what she thought was a small wart on the left cheek about 2 cm. directly below the center of the left eyelid. This started without any apparent cause. It has gradually increased in size until the present time, but has never bled or caused any pain. Has had no treatment whatever for it.

Family history: negative, excepting that she believes her maternal grandfather, who died at about the age of 50, may have had cancer of the stomach.

PRESENT CONDITION LOCAL There is a warty growth roughly circular, about 1 cm. in diameter, located about 2 cm. directly below the center of the left eyelid. It has an estimated thickness of 4 mm. It seems to be entirely in the skin and is freely movable, not being attached to the structures below. The surface is rough and horny but not ulcerated. Excepting for this growth, the skin on the face is unusually clear for a woman of her age.

GENERAL Health seems excellent - is active, has a good color. Systolic blood pressure of 150 and diastolic pressure of 95.

BLOOD FINDINGS Not noted.

DIAGNOSIS Evidently a simple epithelioma of the skin, strictly localized.

GROUP

MICROSCOPICAL FINDINGS No section taken.

PROGNOSIS / RECOMMENDATIONS Prognosis good. Radium treatment recommended with the expectation of an easy cure

CHARGE None. (Doctor's wife)

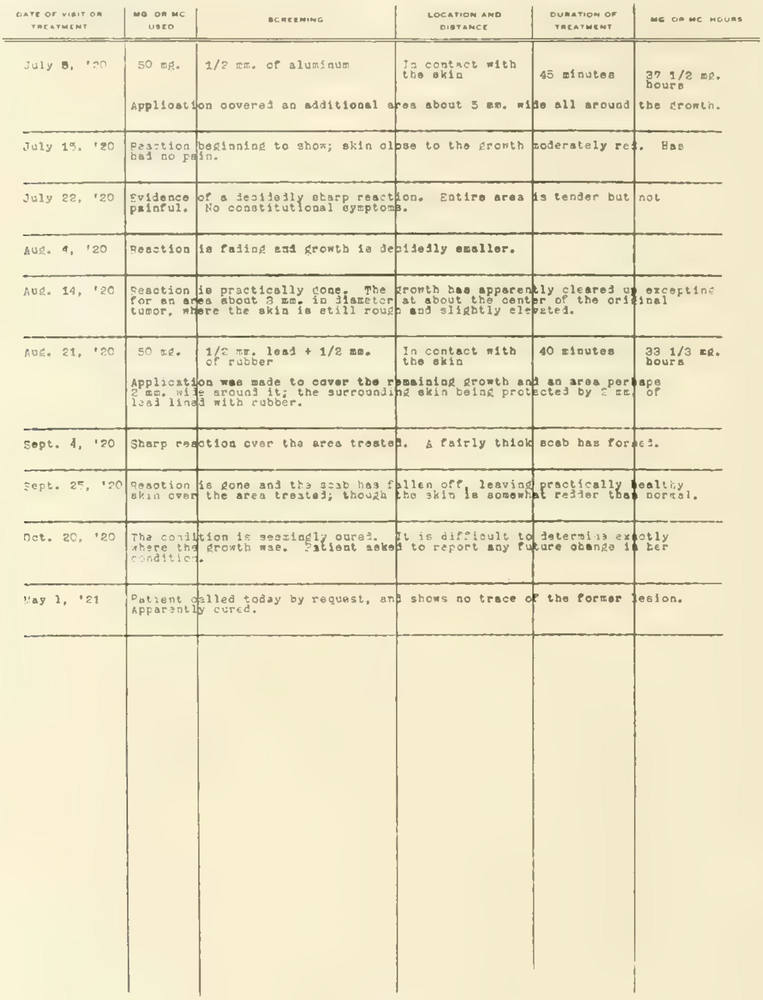
FINAL SUMMARY / REMARKS Apparent cure. Had the first dose been 25% larger, the second treatment might not have been necessary.

FIG. 3.

Should this side of the sheet not be of sufficient length to hold the entire history, a second chart may be attached to this, or a sheet of plain paper of the same size and with the same ruling may be used. These are best held together at the top by a paper fastener which cannot slip off. With the great majority of cases, it will save time and space to make a diagrammatic record of the extent and location of the lesion on printed anatomical sheets such as are sold by the American Medical Association.

It will be observed that this chart does not in any way conflict with the suggestions of the Research Committee of the Society, but that it allows of much more detail.

The writer understands that this chart is far from perfect, and therefore would much appreciate criticism of it, as it is his wish to make it as practical and comprehensive as possible.



DATE OF VISIT OR TREATMENT	MG OR MC USED	SCREENING	LOCATION AND DISTANCE	DURATION OF TREATMENT	MG OR MC HOURS
July 8, '20	50 mg.	1/2 mm. of aluminum	In contact with the skin	45 minutes	37 1/2 mg. hours
	Application covered an additional area about 5 mm. wide all around the growth.				
July 15, '20	Reaction beginning to show; skin close to the growth moderately red. Has had no pain.				
July 22, '20	Evidence of a decidedly sharp reaction. Entire area is tender but not painful. No constitutional symptoms.				
Aug. 4, '20	Reaction is fading and growth is decidedly smaller.				
Aug. 14, '20	Reaction is practically gone. The growth has apparently cleared up excepting for an area about 3 mm. in diameter at about the center of the original tumor, where the skin is still rough and slightly elevated.				
Aug. 21, '20	50 mg.	1/2 mm. lead + 1/2 mm. of rubber	In contact with the skin	40 minutes	33 1/3 mg. hours
	Application was made to cover the remaining growth and an area perhaps 2 mm. wide around it; the surrounding skin being protected by 2 mm. of lead lined with rubber.				
Sept. 4, '20	Sharp reaction over the area treated. A fairly thick scab has formed.				
Sept. 25, '20	Reaction is gone and the scab has fallen off, leaving practically healthy skin over the area treated; though the skin is somewhat redder than normal.				
Oct. 20, '20	The condition is seemingly cured. It is difficult to determine exactly where the growth was. Patient asked to report any future change in her condition.				
May 1, '21	Patient called today by request, and shows no trace of the former lesion. Apparently cured.				

FIG. 4.

TWO IMPORTANT POINTS FROM THE RADIUM THERAPIST'S STANDPOINT REGARDING CANCER IMMUNITY*

BY CARROLL CHASE, M.D.

BROOKLYN, NEW YORK

As a premise to the subject, it must be granted that every individual possesses a certain inherent resistance to cancer, no matter of what type. This ordinarily is referred to as "cancer immunity." Were it not for this natural resistance, cancer would be a very much more rapid and fatal malady than it now is. As a corollary it follows that the man treating cancer, be he physician, surgeon, or radium or *x*-ray therapist, should always bear this fact in mind, and do everything within his power to conserve this immunity.

The writer makes no pretense of having anything particularly new to present regarding this subject, but he does feel very strongly that the arguments which follow, and the conclusions to which they lead, have never been sufficiently emphasized or heeded, and that they really deserve thoughtful consideration.

What this immunity is, and where it resides, is today not known; but the time is undoubtedly coming when we will have much more knowledge regarding it. However, there is already considerable evidence that some substance, existing largely or entirely in the blood, accounts for the phenomenon of immunity. It seems to be definitely established that this immunity-giving substance (or substances) really exists, and that it is the loss or diminution of it, and not the production of a new poison in the later stages of cancer, which accounts for the train of symptoms indicating loss of immunity.

An example of the attention which is being given to the various blood findings in cancer, may be found in the studies of Dr. Georgine Luden of Rochester, Minnesota, on "Cholesterol," published in the *Journal of Laboratory and Clinical Medicine*, October, 1918, iv, No. 1. The conclusions are too lengthy to be quoted here.

There has been gathered a certain amount of evidence that the two procedures of blood-letting (especially repeated hemorrhage) and anesthesia with one of the solvent group of anesthetics (ether, chloroform or ethyl chloride) both tend to lower, if not to destroy entirely, an individual's immunity against cancer. There is accurate proof of this as to mouse tumors of various kinds; but for obvious reasons, similar experimental work cannot be done on man.

Attention is drawn particularly to an article by Gaylord and Simpson, of the New York State Institute for the Study of Malignant Disease, at Buffalo, entitled, "The Effect of Certain Anesthetics and Loss of Blood upon the Growth of Transplanted Mouse Cancer," which appeared among the proceedings of the Ninth Annual Meeting (May, 1916) of the American Association for Cancer Research, and which was printed in the *Journal of Cancer Research* for July, 1916, 1, p. 379. The discussion of this paper is also given. Experiments here reported show that either a repeated moderate loss of blood or anesthesia with chloroform or ether (the effect of the former being the worse) very definitely affected the animal, so that inoculation with cancer substance from another mouse was almost invariably followed by tumor formation; while the control mice, neither bled nor anesthetized, showed sufficient resistance in about one-half the cases so that similar inoculation was entirely unsuccessful. A personal communication from Doctor Gaylord, in October, 1920, says: "The experimental evidence of immunity indicates the same phenomena, both in carcinoma and sarcoma."

Is it not true in looking back over one's experience for a period of years in the surgical treatment of cancer, that many cases can be recalled where the patient went downhill rapidly after an operation, which, although perhaps not serious in itself, entailed a general anesthetic, and a greater or less loss of blood? Is it not equally true that as soon as a cancer patient begins to bleed to any extent, the general condition often becomes worse with a rapidity seemingly out of proportion to the amount of blood lost? That is to say, very much less harm would be done by a similar loss of blood in a non-malignant disease of comparable severity. If these observations are correct—and in the writer's experience, they seem to be—would it not be wise to make it a rule to use gas-oxygen when a general anesthetic is really necessary, or to use local or spinal anesthesia, as is most indicated? Thinking along similar lines, should not every necessary operation for malignant disease be made as nearly bloodless as possible? In another personal communication, Dr. Gaylord states further: "Since our original observation, no case in our hospital has been operated upon except by the use of gas or local anesthesia, and I have strongly advocated the absolute avoidance of the solvent group of anesthetics." Suppose, for a moment, we say that there is probably no truth in the theories here advanced regarding cancer immunity, but that we admit the bare possibility of their being true; would it not still be the part of wisdom to use the safeguards that have been indicated; especially as they make the surgeon's work no more difficult or dangerous, while they may do much for the patient?

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

To continue: if our line of reasoning thus far has been logical, it is an excellent argument for the use of radiation therapy, be it radium or *x*-ray, in every case in which it offers as good or nearly as good a chance of cure or palliation as would operation; because, ordinarily, radiation therapy does not require any general anesthetic, and further, because it is almost always bloodless.

SUMMARY

There is some evidence, which, though admittedly not conclusive, is certainly suggestive, that the use of any of the solvent group of anesthetics (chloroform, ether or ethyl chloride) or that the loss of blood in any considerable quantity tends to lower or destroy an individual's resistance or "immunity" against cancer.

Even the bare chance that this is true makes it seem wise to avoid entirely the use of the solvent group of anesthetics in malignant disease, and to make any necessary surgical procedure as nearly bloodless as possible.

Radiation therapy, using either radium or the *x*-ray, as is indicated, because such treatment ordinarily requires no general anesthetic and is bloodless, should be the method of choice in all cases where surgery does not offer a distinctly better chance of cure or palliation.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY
Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

MIDWINTER MEETING CENTRAL SECTION AMERICAN ROENTGEN RAY SOCIETY

SEELBACH HOTEL, LOUISVILLE, KY., FEBRUARY 24, 1923

THE FOURTH ANNUAL MEETING OF THE EASTERN SECTION OF THE AMERICAN ROENTGEN RAY SOCIETY

The Fourth Annual Meeting of the Eastern Section of the American Roentgen Ray Society was held at the Ritz-Carlton Hotel, Atlantic City, N. J., January 25, 26, 27, 1923, under the presidency of Dr. Charles A. Waters of Baltimore. There was an attendance of approximately three hundred and fifty members and guests.

A very complete and interesting program was provided by the President. Notable among other features were: *Localization of Brain Tumors by Cerebral Pneumography*, by Dr. Walter Dandy of Baltimore, and an illustrated address, *A Diagnosis of Brain Tumors Based upon the Clinical History, Examination, X-Ray, and the Pathology as Exposed by Operation*, by Dr. Joseph C. Bloodgood of Baltimore.

Considerable time was devoted to a discussion of deep therapy, with consideration of dosage estimation and the most suitable technique, especially in cases of malignancy. In these discussions Dr. J. T. Geraghty of Baltimore and Dr. F. C. Wood and Dr. James Ewing of New York participated.

At the executive meeting which followed the scientific sessions, the following officers were elected for the ensuing year:

President: Dr. Thomas A. Groover, Washington, D. C.

Vice-President: Dr. Charles Eastmond, Brooklyn, N. Y.

Secretary: Dr. William C. Wescott, Atlantic City, N. J.

The manufacturers exhibited a very comprehensive line of their new developments.

Charles Eastmond, M.D.,
Secretary.

CORRESPONDENCE

To The Editor:

At the last meeting of the American Radium Society, the late Dr. Russell H. Boggs and I made a real effort to get recognition of radium as an office expense, or to obtain some depreciation value. We foresaw the possibility of our radium decreasing tremendously in value. As a matter of fact, it has decreased in value fifty dollars a milligram, which receives no recognition from the government unless the loss is established by sale. We employed Mr. Charles M. Johnston to present this matter at Washington, together with a petition signed by the radium owners; and I am enclosing herewith his final report,* which I think should be published in the Journal, so that all the members may know what has been done.

Yours very sincerely,
George E. Pfahler,
Ex-President, American Radium Society.
Jan. 20, 1923.

---

*In addition Mr. Johnson's letter will be found at the end of the editorial section.

DECISION OF INTERNAL REVENUE COMMISSIONER ON APPLICATION FOR CHANGE IN RULING ON RADIUM

Reference is made to your recent request on behalf of the American Radium Society and of other owners of radium in the United States for a reconsideration of O. D. 837 in which it was held that the cost of radium used as a therapeutic must be treated as a capital expenditure and that radium is not subject to depreciation.

You state that owing to the great cost of radium, the experimental character of its use, and difficulty in selling it and the possibility of the discovery of some method of treating cancer which will decrease the market value of radium you consider that a depreciation allowance of fifteen per cent should be granted or that physicians using it should be permitted to treat the cost as a business expense in the same manner as the cost of drugs.

The motives of policy which you have suggested such as the desirability of encouraging the use of radium and preventing the commercialization of its use may not be taken into consideration by this Bureau in administering the Federal Income tax laws, however excellent these motives may be. The test of the allowance of this deduction is the same as the test of the allowance of every other deduction and depends upon whether it meets the requirement of the statute. The Bureau is without authority to set aside the express provisions of the Revenue Act of 1921 or any other revenue act even if the administration of these provisions imposes a hardship upon the taxpayer or group of taxpayers.

The provisions of the Revenue Act of 1921 relating to depreciation are set forth in Section 214(*a*) (8) which provides for the allowance of:

"A reasonable allowance for the exhaustion, wear and tear of property used in the trade or business, including a reasonable allowance for obsolescence. In the case of such property acquired before March 1, 1913, this deduction shall be computed upon the basis of its fair market price or value as of March 1, 1913."

Under this section the allowance of depreciation is limited to such property as is subject to "exhaustion, wear and tear," that is, to property that has a life extending beyond a year but is not of such indefinite life that the depreciation which it sustains is negligible. The measure of depreciation is based on the probable life of the property as determined from its character and use.

An arbitrary deduction of fifteen per cent for depreciation, therefore, is not allowable as the depreciation of radium cannot possibly be based on a probable life of six and two-thirds years. On the contrary, as it was set forth in O. D. 837, the life of radium is so indefinite that depreciation is negligible.

It is also not possible to allow the deduction of the cost as an item of expense. Inasmuch as radium is not a material consumed or worn out through use during the taxable year, it represents a capital expenditure which under Section 215(*a*) of the Act is not deductible.

With reference to your statement that the discovery of a new method of treating cancer may result in rendering the use of radium obsolete, you are advised that in the event of its becoming obsolete a deduction for the loss of useful value may be claimed in the return for the year in which its use is abandoned. If the radium is sold at a loss either by a taxpayer or his estate, the loss may be claimed as a deduction from any income received whether from professional services or other sources. For this reason it is not believed that any undue hardship is imposed upon physicians using radium for treatment by the application of these principles.

In view of the express provisions of the statute it is not considered that O. D. 837 should be modified or reversed.

Respectfully,
C. P. Smith,
Acting Commissioner.

PRESENT RULING

Since the full life of radium has been scientifically estimated at such an extended period and since no appreciable depreciation results from its continued use as a therapeutic agent, the depreciation occurring during the lifetime of any individual owner is practically negligible. It is held, therefore, that radium which is used as a therapeutic is not subject to depreciation for income tax purposes and its cost must be treated as capital expenditure. The return of capital will be realized upon its sale or other disposition.

Cum. Bul. No. 4, June, 1921.
Treasury Dept. Page 178,
Office Dec. 837.
Ruling 10–21–1496.

CENTRAL SECTION

FOURTH ANNUAL MEETING

Preliminary Program

The Fourth Annual Meeting of the Central Section of The American Roentgen Ray Society will be held in the Seelbach Hotel, Louisville, Ky., on Saturday, February 24, 1923.

The program as arranged for the meeting is presented herewith. Those who can attend are promised an unusually fine opportunity for discussion. Visitors are welcome to all scientific sessions.

Saturday Morning, 9 o'clock

Dr. Bernard H. Nichols, Cleveland, Ohio.
Urography.

Laboratory equipment. Importance of urography as compared with gastro-enterography. Necessity of careful history and laboratory study to determine the method of procedure. Roentgenologist a consultant and not a technician. Technique. Demonstration of results with lantern-slide illustrations.

Discussion

Dr. W. O. Upson, Battle Creek, Mich.
Study of the Esophagus.

First, Dr. Case's method of examining the esophagus; second, the importance of examining the esophagus in all cases of the barium meal examination; third, the appearance of the normal esophagus; fourth, illustrative cases of the more common lesions, such as cardiac spasm, chronic esophageal obstruction, congenital esophageal obstruction, diverticula, carcinoma of the esophagus, etc.

Dr. John D. Osmond, Cleveland, Ohio.
Obstruction of the Esophagus.

When available in diseases of the esophagus, the direct inspection through the esophagoscope should be made in addition to the fluoroscopic examination and the *x*-ray films. However, the preliminary examination of choice is the *x*-ray. In complete or partial obstruction, at least twenty-five possible causes must be considered. Routine examination of the esophagus should be made in most cases where examination of the stomach is requested.

Discussion

Dr. A. W. Crane, Kalamazoo, Mich.
The Chronic Appendix in Roentgenological Work.

Dr. Alexander B. Moore, Rochester, Minn.
Benign Tumors of the Stomach with the Roentgen Findings in Seven Cases.

Discussion

Dr. W. H. Stewart, New York City.
An Unusual Case of Lymphosarcoma of the Thymus with Metastasis.

Dr. B. R. Kirklin, Muncie, Ind.
Osteochondritis Deformans Juvenalis.

Discussion

Dr. Kennon Dunham, Cincinnati, Ohio.
Acute Pulmonary Tuberculosis.

Discussion

Saturday Afternoon, 2.30 o'clock

Dr. J. M. Martin, Dallas, Texas.
Fifteen Years' Experience with the Fractional Dose Method of Treating Cutaneous Malignancies. (Lantern Slide Illustrations.)

A general review of the roentgen technique used in the treatment of 2,000 cases of cutaneous malignancies. A comparative study of the fractional and massive dose methods as applied to the treatment of malignant lesions of the cutaneous structures. A description of a practical follow-up system covering a period of five years.

Discussion

Dr. A. W. Desjardins, Rochester, Minn.
Protection against Radiation.

General discussion of dangers from radiation to patient and to radiologist, under different working conditions, and methods of protection. Preliminary report of experiments to determine thickness of lead required for protection in therapy laboratories particularly, with results.

Discussion

Drs. Arthur W. Erskine and Scott M. Smith, Cedar Rapids, Iowa.

A Comparative Study of Various Filter Materials.

Reasons for using filters, and desirable qualities in filter material. Description of methods employed in obtaining data. The economical limit of increase in filter thickness and description of a simple method of determining it. Comparison of results obtained using various materials as filters. Possible relation of atomic numbers of elements to efficiency as filters. Conclusions.

Dr. James N. McCoy, Vincennes, Ind.

Physiological Dose of Roentgen Rays.

Reasonable to assume certain doses of *x*-rays adapted to certain purposes. Superficial cancer, object of earliest *x*-ray treatment. Basis for dosage in deeper-seated disease. Destruction of lesion. The object of treatment. Typical desired superficial reaction. Advisable that superficial lesion receive only such rays as are expended in it. Hard rays passed the skin without effect on it. Valueless against skin malignancy. Lethal dose to be avoided in treating hypertrophies. The discovery of Lodge. The governing principle of *x*-ray therapy. Radical versus conservative. Discussion of high voltage treatment. Requisites of curative dose for malignancy. Sufficient intensity to reach the pathology and the required volume of rays to accomplish physiologic change.

Dr. Otto Glasser (by invitation), Baltimore, Md.

Roentgen-Ray Dose.

The measuring instruments which in the practical use of *x*-rays are most employed for the determination of the "practical dose" are the milliammeter and the kilovoltmeter, the latter checked up with the sphere-gap. The most recent measuring instruments based on ionization allow us to determine accurately the quality and the quantity of radiation for every point of the exposed body. This can be done with the Freidrich iontoquantimeter method of determining the "effective wave-length" and measuring the intensity with the Duane ionization chamber and with the method of Dessauer using the Bachem electroscope. To these methods of determining the "practical dose" must be added the important researches on the problem of "absolute dose."

Discussion

Dr. Henry Schmitz, Chicago, Ill.

The Changes in Cervical Carcinomatous Tissue exposed to Radiations.

Discussion

Dr. Charles Goosman, Cincinnati, Ohio.

Results with Modern Radiotherapy in Bladder Tumors.

These cases have not been responding satisfactorily to surgery. The genitourinary specialist will usually be glad to call in the aid of radiotherapy. Results with combined radium and deep roentgen treatment are better than with any previous method. Correct technique important. Preliminary cystotomy a disadvantage.

Dr. William A. Evans, Detroit, Mich.

Result of Deep Roentgen Treatment of Gastrointestinal Lesions.

BUSINESS MEETING

Immediately after the close of the Scientific Session

Election of Officers

SATURDAY EVENING, 7 O'CLOCK

BANQUET

SYMPOSIUM ON THE SACROILIAC AND LOWER LUMBAR SPINAL VERTEBRAE

Dr. Paul Magnuson (by invitation), Chicago, Ill

What May We Call Radiographic Evidence in Low Back Pain?

Dr. Hollis E. Potter, Chicago, Ill.

Radiographic Evidence.

Discussion of this Symposium to be opened by:

Dr. P. M. Hickey, Detroit, Mich.
Dr. Edward S. Blaine, Chicago, Ill.

Lantern Slides.
Notify Dr. D. Y. Keith, Suite 746 Francis Bldg., Louisville, Ky., number of slides you wish to present.

COMMERCIAL EXHIBITS

SUNDAY PROGRAM

Golf
Sight Seeing

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page i of this number of the JOURNAL. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Dear Dr. Pfahler:

Pursuant to the instructions of yourself and Dr. Russell H. Boggs, of this city, I at once began the preparation of a petition to be filed with the Internal Revenue Office at Washington, requesting a modification of the present ruling on radium.

The untimely death of Dr. Boggs was a real misfortune in this matter, as he was very familiar with many facts that would certainly have had weight with the Department at Washington. However, after considerable labor and investigation, I prepared a petition asking that the present ruling be modified either by permitting the cost of radium to be charged as a current expense, with a provision to the effect that in the event of the subsequent sale of the radium the selling price would be charged as income, or that a depreciation allowance be allowed each year on all radium held by physicians and used for therapeutic purposes.

The petition was very lengthy, covering about ten typewritten pages, and later, a five-page supplement, amplifying some of the arguments in the original petition, was added. Both the original and the supplement were presented by me to Commissioner Blair, of the Internal Revenue Department, and one of his assistants, Mr. Mattox, at Washington, at a conference on this matter that lasted upwards of two hours. I had attached to the petition the copy of the resolution passed at the meeting of the society in St. Louis, and also the original petition signed by the physicians individually at the same meeting. I went carefully over all the matters set forth in our petition, resolution and the physicians' petition, with the above-named gentlemen, and was shown every consideration and courtesy by them. Unfortunately however, they were unable to grant us relief.

The decision, a copy of which is hereto attached, explains the position of the Commissioner in detail.

For your information and for the information of any physicians not familiar with the present ruling, I am also attaching hereto a copy of the present ruling, O. D. 837, cited in the Commissioner's decision.

Yours very truly,
Charles M. Johnston.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (69 *East* 59th *Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

WHITCHER, B. R. Blood Changes in Myelogenous Leukemia Following Radium Treatment. *Boston M. & S. J.*, Sept. 7, 1922, clxxxvii, No. 10, 349.

The author's observations led him to believe that the application of radium in myelogenous leukemia does produce an apparently beneficial effect on the patient, if the amount of radium applied is regulated with caution; as the leucocyte count is reduced to nearly its normal level, the myelocytes are greatly decreased, and at times made to disappear altogether, the blood is brought to a more nearly normal appearance, and apparent general improvement takes place in the patient's clinical condition. But the treatment should be given at regular intervals. However, radium is a factor fraught with danger, and caution is necessary in regulating the amount to be applied, lest an excessive dose or too frequent application may cause undue destruction of the leucocytes, and so injure the reproductive powers of the bone-marrow that a rapid leucopenia and anemia result.

As the outcome of the experience of the author and his colleagues at the New York Post-Graduate, the present procedure is to apply the radium over the enlarged spleen only, and over the lymph-nodes, if enlarged; but to let the bone-marrow alone until the myelocytes have entirely disappeared from the blood. There appears to be a danger that, in treating the bone-marrow at the same time, its power to produce new red cells may be weakened so that the red cells and hemoglobin decrease along with the leucocytes.

KIRKENDALL, BEN R. Pre-Operative and Post-Operative Radium Therapy: Report of Cases, Dosage and Methods. *Ohio M. J.*, Dec. 1, 1921, xvii, No. 12, 837.

The author believes that cases of carcinoma of the vagina and prostate are best treated with radium alone. Cases of cancer of the cervix and uterus, which have responded well to the treatment should rarely be hysterectomized later, as distant quiescent diseased cells may be stimulated to recurrence. Radium can be used to advantage before surgery to make non-surgical cases surgical. Radium after surgery may make a success of the operation. Its use in recurrences is palliative, but it may cure.

BROGDEN, JAMES CHESTER. Actinomycosis of the Gastrointestinal Tract. *J. Lab. & Clin. M.*, Dec., 1922, viii, No. 3, 180.

The author reports 14 cases studied in the Mayo Clinic, 13 of the 14 cases having been discovered within the last four years. No report could be obtained of 3. One has been treated only four weeks. Of the remaining 10, 6 are dead with an average length of life after onset of the disease of three years. One patient was operated upon and had no symptoms of recurrence four years afterward. One was apparently cured after four years of medical treatment, and 2 are markedly improved after taking iodides and roentgen-ray and radium treatment. The author concludes that a chronic discharging sinus in the lower abdomen, especially after operation and drainage of an appendiceal abscess, should arouse suspicion of actinomycosis, and repeated examinations for the ray-fungi should be made. Early operation and excision of the diseased area before the infection spreads to the surrounding tissues, frequent roentgen-ray and radium treatments over the abdomen, and large doses of potassium iodid by mouth and sodium iodid intravenously offer the best hope of cure. In the later stages, after extension of the disease to the adjacent organs and sinus formation, radical surgical measures are of no avail. Some patients apparently are cured under treatment with radium, roentgen ray, and the iodides; others improve wonderfully only to have recurrence in from two to four years. Death usually occurs from cachexia and extension of the disease to the liver and thorax.

MACCARTY, WILLIAM CARPENTER. Does Cancer Arise in Chronic Gastric Ulcer? *J. Am. M. Assn.*, Dec. 2, 1922, lxxix, No. 23, 1928.

From an experience of more than 1,400 gastric specimens, MacCarty concluded that cancer is so often associated with chronic gastric ulcer that such a gastric ulcer should always be considered as possibly malignant. He knows of no clinical or laboratory method by which the differential clinical diagnosis can be made. From actual experience, he knows that most chronic gastric ulcers with a diameter greater than 2.5 cm. are cancers. He does not know how to tell whether the ulcer or cancer was primary. Ulcers of the stomach may be divided, for practical purposes, into 5 groups; the simple acute peptic ulcer; the chronic ulcers which are tuberculous or syphilitic; the chronic ulcer, the exact etiological factors for which are unknown; the chronic ulcer in which there is a neoplastic process in the borders of the mucosa; the gastric ulcer which shows carcinoma, not only in the borders, but also in the base. There are no positive clinical signs, symptoms or laboratory tests by which these 5 groups of ulcers can always be differentiated. Advanced carcinomas may be seen with the roentgen ray, and if the roentgenologist discovers an ulcer which he estimates to be larger than 2.5 cm. in diameter, the guess of cancer will be correct in a very high percentage of cases. It is, however, only a guess for practical purposes, but has some value.

THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. X MARCH, 1923 No. 3

NEW GROWTHS WITHIN THE CHEST: X-RAY DIAGNOSIS*

BY SAMUEL B. CHILDS, M.D.

DENVER, COLORADO

NEW growths within the chest present to the roentgenologist complicated problems for diagnosis. As an aid in the solution of these, it is considered necessary to review not only the changes characteristic of new growths, but also those associated with certain inflammatory conditions which may produce a similar appearance.

Growths within the chest may be divided, for the sake of description, into two classes:

1. Those in the mediastinum.
2. Those in the lungs.

Mediastinum. Hodgkin's disease is generally shown by a paratracheal, dense shadow projecting beyond the mediastinum, with a border, either irregular in outline, or circumscribed and clearly defined, which extends over a considerable part of the median shadow. These masses may attain to a large size, projecting beyond the mid-clavicular nipple line, and extend the entire length of the median shadow. Occasionally only a unilateral mass projects at the level of the hilus, circumscribed by a border similar to that above described. The diagnosis in this disease can be confirmed by biopsy.

Lymphosarcoma starts in the mediastinum and is apt to increase rapidly in size and involve the lung or pleura, or both. Illustrative of this condition, the report of the following case is of interest. I am indebted to Dr. S. G. Bonney for the patient's history.

Female, aged twenty-three, married. Previous health good until the spring of 1920. Had been losing weight and strength, but continued to be up and about until April, 1921, when she went to an eastern clinic. Had a slight fever in the afternoon. No tubercle bacilli. No positive diagnosis made. Advised to go home and rest. Had acute mastoid and recovered. Went to California on a pleasure trip; was in Los Angeles three months. Three days after arrival, became ill and been in bed ever since. Severe pain in the left chest. Pain on taking full breath. Fever daily, 100 to 102° F. Chills often, night sweats often. Cough very severe. Very slight expectoration. Cough paroxysmal. July 15th, bowels loose, very offensive mucopus. Pain. Went home to Nebraska first of September. Advised to come here. First aspiration last July, two quarts, cherry red. Second one was made week ago in Nebraska, one pint a.m. and one p.m. same day, same character. Not much improvement in breathing. Reported to Dr. Bonney Sept. 7, 1921. On that day he aspirated and drew a pint of bloody fluid. Patient referred to the writer for an *x*-ray examination Sept. 9, 1921, malignancy being suspected. Patient unable to leave bed and examination was made by portable. The result of this examination is as follows: The left lung is obscured by an extensive effusion with the fluid level surmounted by a pneumothorax in extreme apex. There is demonstrated a paratracheal mass on the right side about 3½ in. long and 1 in. wide in greatest diameter. Heart shadow displaced to the right. No pathology shown in the right lung (Fig. 1). In the diagnosis, two conditions only were considered, sarcoma and Hodgkins. A few small glands were detected above the left clavicle, one of these was removed by Dr. Bonney and the pathologist's report was lymphosarcoma. The patient died about Sept. 20, 1921.

---

* Read in part at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angles, Calif., Sept. 12–16, 1922.

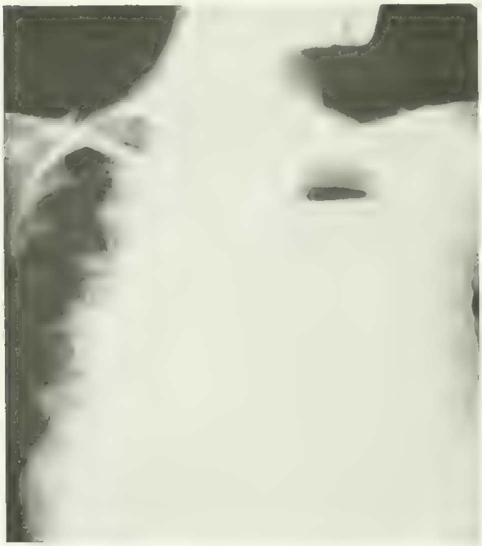


Fig. 1. Lymphosarcoma. Paratracheal mass on right side. Involvement of left lung and pleura with hemopneumothorax of left side. Diagnosis verified by biopsy. For clinical history see text.

Intrathoracic thyroid casts a fairly characteristic shadow of uniform density, in the upper part of the mediastinum. The base of this shadow is situated upward, having a lessened diameter at its lower extremity. The edges of this shadow are generally well circumscribed.

Enlarged thymus should cast a small, inverted, heart-shaped shadow which overlaps the aorta and the base of the heart. A number of the cases in which the diagnosis of enlarged thymus has been made have not been verified by a postmortem examination, hence a diagnosis in this condition is not considered particularly reliable.

Cysts cast characteristic shadows, generally well circumscribed and of uniform density. A dermoid cyst is characterized by a distinctly clear-cut border which circumscribes a roundish, or even quite round, dense area usually projecting from the right side of the mediastinum. This latter variety of cysts is generally single, and occasionally the shadow cast by teeth or pieces of bone may be demonstrated, otherwise only a probable diagnosis is warranted, except in such a case as mentioned by Dr. Hall, where convincing proof is obtained in the expectoration. If, however, repeated examinations over a considerable period of time fail to detect any marked change in the size of the cyst and no evidence of secondary deposits appears elsewhere in the chest, a complement fixation test being negative and the general condition of the patient good, the diagnosis of a dermoid cyst is greatly strengthened (Fig 2).

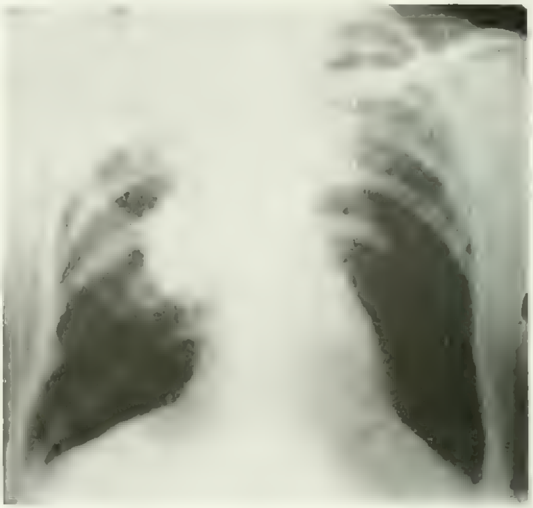


Fig. 2. Tuberculosis in upper half of each lung. Positive T. B. sputum. Sharply defined shadow at hilus of right lung, probably a dermoid cyst. Has not increased in size during several months' observation.

A cyst may be overlooked, especially if its detection be interfered with by the heart shadow. The writer had an experience of this kind about eighteen years ago, before the screen examination occupied the prominent place that it does today. He failed to detect the cyst, which was demonstrated by necropsy, but was impressed clinically with the large area of transmission of the cardiac impulse to palpation. This should have attracted attention to some lesion in the mediastinum, as neither the size of the aortic or heart shadow nor the intensity of the heartbeat warranted any such transmission.

Primary sarcoma frequently has its origin in the thymus or thyroid, and may assume very large dimensions, both in the lateral and anteroposterior diameters, causing severe dyspnea and cyanosis, a fact which was particularly impressed upon the writer by an examination of a patient in the prone posture, who was found, after the plates were developed, to have such a mass. The severity of the dyspnea and coexistent cyanosis was alarming when the patient was assisted from the table. These tumors generally have a roundish shape with a clear-cut border (Fig. 3).

Fig. 3. Sarcoma of mediastinum apparently starting from the thymus. Verified post mortem.

Cold abscess frequently presents an appearance simulating that of a new growth. Its presence is indicated by a dense shadow which overlaps bilaterally that of the spine with its long axis vertical (Fig. 4). It has been my observation that the greatest transverse diameter is apt to be near the middle of the abscess. An ordinary abscess casts a dense shadow which may present itself beyond the edges of the mediastinum, but the diagnosis of this shadow will depend largely upon the clinical history.

Aneurism generally presents but little difficulty in diagnosis. A pulsating, circumscribed tumor with increased breadth in the mediastinal shadow, and a heart situated low, with a flattened left ventricular margin are *x*-ray signs considered diagnostic. Occasionally a case is seen in which the pulsation is diminished, or even lacks expansile pulsation, and which may present some difficulty in correct interpretation. The position and shape of the heart just mentioned will prove of value in making a diagnosis. In a case of this kind the post-mortem examination will probably reveal the aneurismal sac filled with an old organized blood-clot, leaving a practically normal-sized opening through the original channel of the aorta.

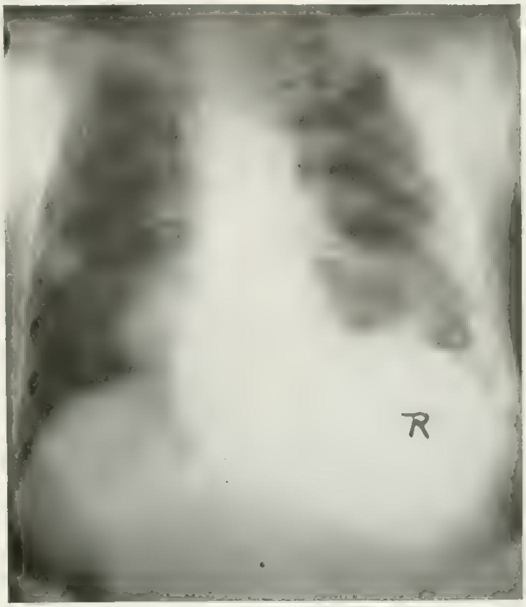


Fig. 4. Large cold abscess situated behind and extending below the heart. Verified post mortem.

An aneurism may simulate, however, the appearance of a cancer of the lung or a tumor of the mediastinum.

One or more masses may signify the presence of tuberculous glands, or may indicate a primary or secondary cancer. The shadows cast by these are practically similar. A distinguishing point from the source of origin is that tuberculous masses are generally found in the posterior mediastinum, while cancerous nodules are more frequently in the anterior mediastinum, with the exception of a carcinoma involving the esophagus, which should be mentioned in the growths of the mediastinum. This condition requires confirmation by the aid of an opaque mixture in the esophagus.

New growths in the lung are subdivided under the heading of benign and malignant.

If we exclude the massive deposits frequently found in pneumoconiosis from the list of the new growths, benign growths in the lung are very rare. I have never seen a case of echinococcus cyst. These, however, do occur and appear in the lower lobe of the right lung. Dr. Hall reports to me that he saw in his own practice a case of echinococcus cyst in the lower lobe of the right lung, which was verified post-mortem and by the microscope. This case was observed a number of years ago, before *x*-ray examinations were made.

Malignancy of the lung is divided into two classes, primary and metastatic.

Primary sarcoma of the lung is very rare. The writer has no proved case to report, but the clinical diagnosis of primary sarcoma of the apex of the right lung seems warranted in the following case:

Male, aged twenty-three, referred by Dr. Arneill, for an *x*-ray examination Jan. 24, 1916. I am indebted to him for the following history and physical findings: The chief symptom was a dull pain in the right back between the shoulder-blade and spine, also in a similar locality in the right chest and axilla. Has had the pain in the back for six or seven months. A cough has been present for four months, with very little expectoration. Had an attack of grippe about one month ago, with fever. Has lost considerable weight, and there is at present considerable numbness along the course of the right intercostal nerves. Appetite and digestion fair. Physical signs: right side shows diminished expansion, right apex and right infraclavicular region to third rib are dull. High-pitched blowing breathing over the area of dulness, also whispered pectoriloquy, high-pitched blowing breathing over the right back to the middle of the scapula. No signs of moisture detected in the chest. Left radial pulse considerably stronger than the right. Pulse 96. Temperature 99.2° F. Heart dulness normal, also the heart sounds.

The *x*-ray examination showed a uniformly dense, roundish shadow involving the upper part of the right lung, with a clear-cut border and no sign of involvement of contiguous lung tissue. No other pathology shown in the lung or the mediastinum (Fig. 5).

Diagnosis. New growth in the upper part of the right lung, probably primary sarcoma. The patient died within two months from the time of examination.

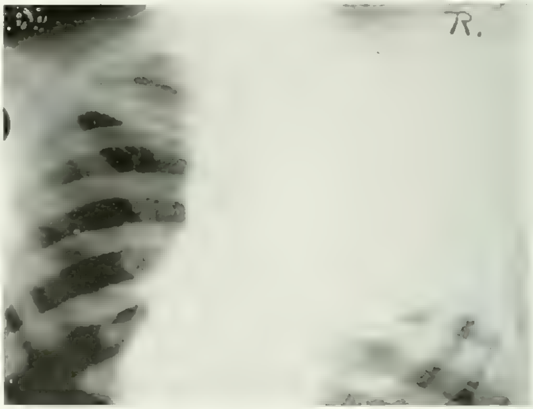


Fig. 5. Clinically this is considered a primary sarcoma of the right lung. For history and physical findings see text.

The primary type of carcinoma is not common, but it occurs with sufficient frequency to make the roentgenologist bear this disease in mind in all lung cases in which the *x*-ray, clinical and laboratory evidence do not warrant the diagnosis of any of the more common pathological conditions. Especially is this so when the symptoms are distress or pain in the chest, dyspnea and the presence of bloody or prune-juice expectoration. In looking over the literature, the writer finds several descriptions of this condition, and takes the liberty of giving the following opinions:

Carman considers a dense lobar shadow with smaller areas suggesting metastasis as characteristic.

Christie divides primary cancer into two types: infiltrative and miliary.

Infiltrative is a roughly circular shadow extending outward from the hilus, shading off into the lung shadow and with processes radiating into the lung. Outside this area are evidences of congestion. In addition to this picture, a few nodules with indistinct edges surrounding the central shadow or in relation with the bronchial trunks near the periphery complete the characteristic picture.

Miliary type has diffuse nodulations throughout the lung with hazy periphery and surrounding zone of congestion.

Holmes and Ruggles state that primary cancer is practically always unilateral and presents two types: nodular and infiltrative. The former consists of dense rounded masses occurring near the hilus, and sharply marked off from the surrounding lung tissue.

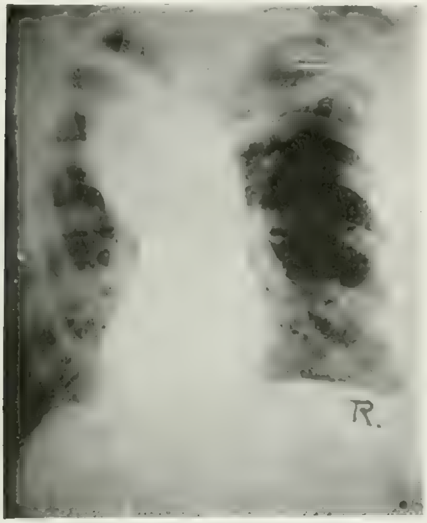


Fig. 6. Primary carcinoma extending upward from root of left lung. Appearance simulates that of aneurism. Verified post mortem.

The infiltrative type arises from the bronchus, and infiltrates the lung along the bronchial ramifications, causing an increased density of the lung markings, or it may involve the surrounding lung tissue and be seen as a mass with fairly smooth edges, except for the advancing margin, which is irregular.

A number of other observers recognize two divisions of cancer, namely, that of a lobe and that of the hilus, also that hilar lesions predominate over lobar, and that the majority of hilar lesions invade the parenchyma in their progressive development.

The writer reports 2 cases of primary carcinoma of the lung, verified by necropsy and pathological examination. One of these cases is presented through the courtesy of Dr. Bronsis of the Jewish Relief Society (Fig. 6).

The metastatic deposits of cancer may be general in both lungs, or confined to one lung. The lesions on the *x*-ray plate consist of general nodulations in the lung or localized deposits in the line of the lung markings, generally involving the lower half of the lung, and apparently starting from the hilus. The appearance of metastatic deposits is practically that mentioned for primary lesions and a careful necropsy may be necessary for differentiation, provided the clinical history does not give convincing evidence (Fig. 7).

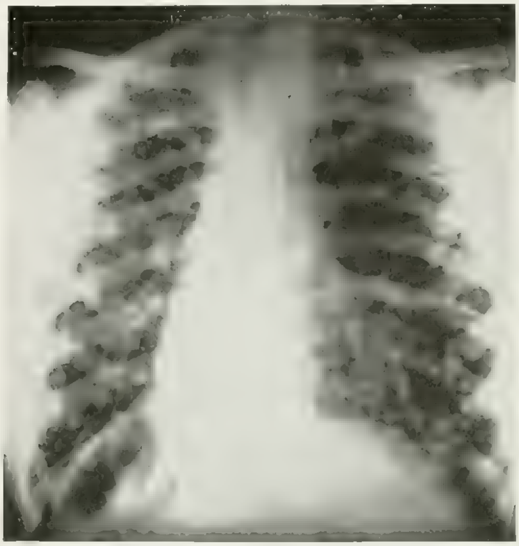


Fig. 7. Metastatic carcinoma of lungs secondary to carcinoma of stomach. Verified post mortem.

Where the pleura is primarily involved in the metastasis before the lesions are demonstrated in the lung, the first sign detected may be only a restricted motion of the diaphragm on the affected side.

Metastasis of the lung is comparatively frequent, especially secondary to carcinoma of the breast, and if an *x*-ray examination were made in all cases of this latter disease, some radical operations for the removal of the breast would be deemed inexpedient.

In the differentiation between benign and malignant growths of the lung it is a fairly accurate statement that benign growths are sharply defined, whereas in malignant growths, the absence of a clear-cut border, with a hazy area extending into the surrounding lung structure is to be expected. Also, it is the general experience that sarcoma presents a more sharply-defined border than is found in carcinoma. This fact is well exemplified by the clear-cut contour of rounded sarcomatous tumors of the mediastinum.

Benign growths and circumscribed shadows simulating the appearance of growths must be considered in the differential diagnosis. Among these, mention is made of cysts, abscesses, encysted empyema, syphilis, massive deposits from pneumonoconiosis, unresolved pneumonia, interlobar effusion, bronchiectasis and tuberculosis.

Whereas the clinical evidence will, as a rule, readily differentiate most of these conditions from cancer, yet from an *x*-ray standpoint alone, differential diagnosis from cancer is often difficult, if not impossible.

The appearance of a cyst has already been described.

Abscess of the lung is generally single and casts a shadow of fairly uniform density, though not infrequently the center of this shadow presents a lighter area, and at times a fluid level can be detected. The margin of this shadow may be clear-cut, but it usually has a hazy irregular border. The shape of the abscess, in the writer's experience, has most frequently been found either roundish or elliptical.

Encysted empyema usually presents a sharp border, clearly separated from the lung structure, and casts a uniformly dense shadow.

There are no changes in the lung that are considered peculiar to syphilis. A gumma may exist and be indicated by a massive shadow in any part of the lung, with probably small, nodular, hazy shadows in some other part of the same lung. Another type of this disease may show more or less extensive parenchymatous involvement characterized by irregular nodular shadows, varying in size, with hazy margins. We may also find only increased density of the hilus with increased area of shadows extending into the lung substance.

A valuable aid, however, in the correct interpretation of these shadows, may be found in the cardiovascular changes in the chest which are so frequently found in syphilis.

A positive Wassermann is an even more valuable aid, and a more important one still is the disappearance either partially or entirely of the lung involvement under specific medication, for it must not be forgotten that syphilis and other diseases of the lung may coexist, or that a positive Wassermann does not necessarily signify that the lung changes found in a given case are due to syphilis.

Pneumonoconiosis is manifested by small nodular deposits distributed in the line of the bronchial radiations, and may be mistaken for a similar type of peribronchial deposits from cancer. If carefully observed, however, the hazy edge of the cancerous nodules shading off into the inflammatory lung tissue is in marked contrast to the appearance of the more sharply cut edges in pneumonoconiosis. Furthermore, the latter nodules are bilateral and fairly symmetrical, while in cancer the nodules may be unilateral. The heart shadow is usually enlarged in pneumonoconiosis.

Definite massive deposits from pneumonoconiosis when situated above the hilus of the lung may present an appearance of aneurism. Such a case was reported by Dr. Sewall in *The American Journal of the Medical Sciences* for January, 1906.

An *x*-ray examination was made by the writer of this case on May 5, 1904. A systolic bruit was detected by Dr. Sewall over the lower half of the right scapula, which was suspected, in view of the suspicion of syphilitic infection, to be caused by a thoracic aneurism.

The report based upon the *x*-ray examination of this case is as follows: Heart is situated low in the chest. The shadow of the aorta seems broader than normal. Both sides of the diaphragm move fairly well, the left more than the right. There is seen best from the back, projecting into the right lung, a rather dense shadow, somewhat rectangular in shape. It fuses on the inside with the shadow of the base of the heart and ascending aorta, with a surrounding clear space externally above and below. No pulsation is detected in this shadow, but the shadow is of uneven density. In each lung are seen a number of dense circumscribed deposits.

Diagnosis. Circumscribed mass in the right lung extending toward the median line of the sternum. Negative for aneurism.

Necropsy Report. At the root of the right lung is found a hard solid mass ovoidal or pyriform in shape, 4 in. long, 3½ in. wide and 2½ in. deep, which reaches the posterior surface of the lung. Hard black nodules the size of duck shot are scattered through the upper lobe. On section, the mass at the root of the lung is found to be black in color and gristly in resistance.

Diagnosis. Anthracosis.

Massive deposits may also simulate the appearance of cancer.

Unresolved pneumonia presents an appearance which, without the aid of the clinical history, may be impossible to differentiate from cancer.

In interlobar effusion we find a shadow sometimes described as a hanging shadow from the hilus, and if not too extensive, the shape of this shadow and its direction should conform to the line of the fissure. If, however, the effusion is quite extensive, its shadow may obscure nearly the entire lung. The writer has observed in 2 such cases that the costophrenic angle is not dense like the remaining shadow, in contrast with the shadow cast by a general effusion obscuring cancerous deposits or an extensive pleurisy with effusion from any other cause.

The condition of bronchiectasis is typified chiefly by marked thickening of the lower radiations on each side, and, according to the extent of the lesion, there may be small pseudo cavitations. In cancer, the lesion is generally unilateral and, whereas it may be confined to the lower lobe, it frequently extends directly outward from the hilus of the lung as well. The clinical diagnosis of bronchiectasis is generally self-evident.

When tuberculosis is associated with areas of caseous pneumonia, the lung changes may closely simulate those of cancer. But in this latter condition, the lesion seldom involves the apex, while in tuberculosis, the apex is generally definitely

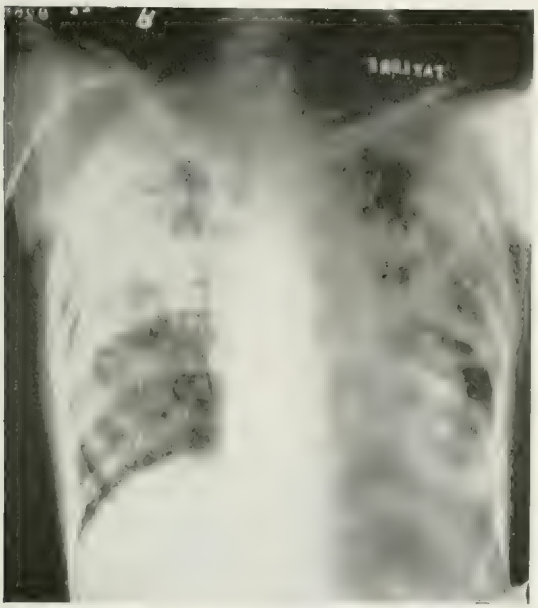


FIG. 8. Extensive tuberculosis both lungs. Positive T. B. sputum. Appearance simulates carcinoma of the lung.

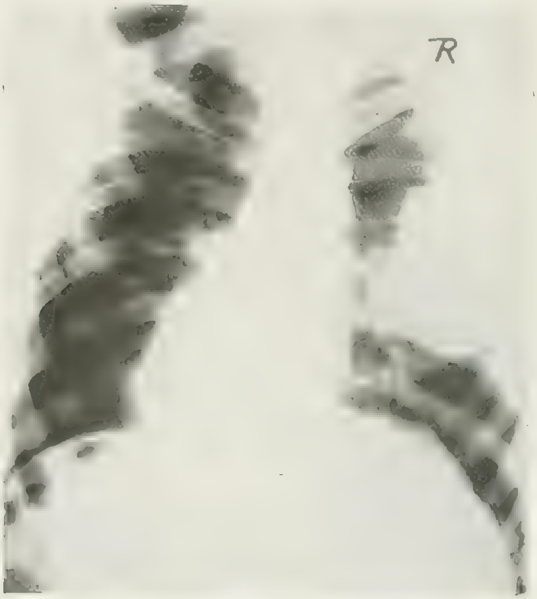


FIG. 9. Probable syphilis of right lung. Symptoms: pain in chest, occasional shortness of breath, very little cough, about normal weight. Had pneumonia two years ago. 4 plus Wassermann. Definite improvement under antiseptic treatment.

involved, and if there are hilar shadows in each condition, the larger size of these and their irregular edges with the changes above described, extending into the surrounding lung tissues, are valuable aids in the differential diagnosis (Fig. 8).

In the miliary type of tuberculosis, the deposits are smaller, as a rule, than those found in cancer, and are apt to be fairly uniform in size, and will probably have a hazy border. However, the writer has observed one case of general carcinomatous deposits, as far as determined by postmortem examination, in which the deposits were small, like those ordinarily found in miliary tuberculosis.

SUMMARY

The *x*-ray furnishes valuable evidence in all new growths within the chest, and in some of these conditions a positive diagnosis can be made from its use alone.

It is considered, however, that in all cases of new growths, the *x*-ray should be combined with the clinical and laboratory evidence, before a positive diagnosis is made.

Primary carcinoma of the lung presents, generally, a fairly definite group of symptoms as well as a rather typical *x*-ray picture, and, although it is not common, yet it occurs sufficiently often for the clinician and the roentgenologist to bear the possibility of its existence in mind, when the findings in a given case are not satisfactorily accounted for by the diseases ordinarily found in the lungs. When the combined evidence is before us, mistakes in this diagnosis will be greatly lessened.

NEW GROWTHS WITHIN THE CHEST*

BY J. N. HALL, M.D.

DENVER, COLORADO

WE believe the following statements will justify us in presenting to this Association the general subject of the Diagnosis of Malignant Diseases Within the Chest:

It is realized everywhere that such disease is becoming more common, the proof from autopsy statistics alone being sufficient to establish this point.

The diagnosis is made in 80 or 90 per cent of cases in certain clinics, but in only occasional instances in others. It is obvious that, if the knowledge and facilities which enable certain physicians to make the diagnosis in most cases were in the possession of all physicians, failure of diagnosis would be infrequent. We are of that number who believe from experience that the diagnosis can be made in a very great majority of cases.

Malignant disease within the chest chiefly involves, primarily or secondarily, the following organs:

The lungs, including the bronchi,
The pleurae,
The mediastinal glands,
The thymus,
The thyroid,
The esophagus.

Teratomata should also be considered.

The Lungs and Bronchi. It is in this field that the recently noted increase of malignant disease has chiefly occurred, and the opinion is general that the source of the growths lies in the frequent residual lesions left in the wake of the great epidemic of influenza. The frequently reported evidence of origin from bronchiectatic cavities, tuberculous cicatrices, and other foci of inflammation is noted on every hand. It is probable that the cases noted in the German literature, as originating in the miners of cobalt, nickel and bismuth, in the Schneeberg district, and in the sandstone workers near Dresden, are, like the occasional cases in this country in miners, the result of irritation of lungs, bronchial mucosa or bronchial glands by the various irritants mentioned. Doubtless a chronic inflammatory lesion always precedes the malignant growth. The frequency of cancer of the bladder in anilin workers is of interest in this connection. One of us[1] saw cancer of the lung in an oil refinery employe subjected in his work to exposure to very irritating gases. The case reported by Chevalier Jackson, of cancer developing about a foreign body which had remained in the bronchus for thirty-five years, is worthy of mention.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

The preponderance of males in the case reports is doubtless in part due to the fact that occupational disease, such as pneumonoconiosis, as seen in miners, marble workers, grinders, and others, which disease predisposes to malignancy, is practically limited to the male sex.

The preponderance of cases after forty years of age is the natural result of the circumstance that a long-continued inflammatory process precedes malignant change.

The development of carcinoma or sarcoma shortly after trauma has been observed, but a causal relation is scarcely established.

Why right-sided disease is more frequent is not known, but the relatively greater bronchial and glandular preponderance upon this side is probably a factor.

The histology of the growths in the lung has been extensively studied by others, and we shall in this article speak in general terms only of cancer and sarcoma.

Primary Cancer. Pfahler mentions the sharply-defined, nodular type of cancer at the root of the lung, and the infiltrating type, spreading outward and upward from the hilus, especially along the bronchial tree. The mediastinal shadow is often broadened. The disease occasionally spreads along the thoracic duct, and chylous ascites or hydrothorax may result. The tendency of inflammatory thickening to involve the bronchi running downward from the hilus is well recognized, especially since the great epidemic. This forms a valuable differential criterion.

Secondary carcinomatous involvement of the lung is very common. Warfield, in 516 autopsies in cancer of the breast, found the lung involved by metastasis 1-8 times. While direct extension through the chest wall in breast cancer leads to metastasis in the lung of the same side, extension from growths elsewhere in the body commonly leads to a bilateral development in the lungs.

Carman believes that cancer is often carried by embolism through the blood-vessels, although lymphatic distribution is probably the rule.

Metastasis from primary cancer of the lung is most frequent in the lymph-nodes, next, in the liver, while the bones and other organs are occasionally affected.

Primary sarcoma spreads outward more especially about the median fissure on the left, or the median lobe on the right. Secondary sarcoma, however, is more often seen as a late development in sarcoma of the testicle. Nodules appear in the parenchyma of the lung, emboli having been carried to the terminal vessels through the blood stream. Metastasis of hypernephroma to the lungs is common enough to justify Pfahler's statement that the lung should always be examined roentgenologically in such cases. Miliary involvement outward from the root of the lung is the rule.

Knox's recent report upon the relationship of massage to tumor metastasis is of extreme interest. In animals, gentle massage for a total period of two to five minutes, distributed over several days, has repeatedly resulted in the development of embolic metastasis in the lungs. Only tumors which grow readily when implanted in subcutaneous connective tissue take readily in the lungs. With Dr. I. C. Mierley, we have just examined a patient with metastasis to the glands in the right lower abdomen, a few weeks after the removal of the right testis for sarcoma. He casually stated that he had had a chiropractic treatment of these glands a few days before. The possibility of metastasis to the lungs so monopolized my attention that I desisted from the examination and asked if he had a cough; then if he had expectoration, and then if it was bloody. I received a positive answer to all three questions. A plate of the lungs, made shortly afterwards, showed extensive pulmonary metastasis.

Symptoms. These are commonly due more to the inflammation accompanying the growth than to the growth itself. A dry cough is generally the first symptom noted. It may constitute the only evidence of disease even for several months. A thin mucous expectoration soon follows, and not infrequently a blood-stained, tenacious, even jelly-like sputum.

---

[1] Dr. Hall.

In the primary cases, further symptoms do not develop until the growth of the tumor mass or masses causes erosion, giving rise to hemorrhage, or pressure, leading to pain and notable dyspnea. Marked weakness, cachexia and fever appear later. A terrible feeling of oppression in the chest is noted when the growth is a massive one. After considerable pressure has developed, secondary bronchiectasis may give rise to a purulent sputum or the addition of purulent elements to the sputum. The presence of fever is certainly not to be taken as against the diagnosis of cancer, since it is present in at least half the cases. It may arise from associated suppurative processes, or directly from the malignant process. The appearance of effusion, generally bloody in character, and producing, if large enough, the usual cardiac displacement, is to be taken as evidence of malignant pleural involvement.

The varying character of the dyspnea is worthy of study. A very moderate shortness of breath is the rule early in the disease. With the appearance of the effusion, the dyspnea increases, as also in case of extensive infiltration of the lung. The extreme types signify that extension to the mediastinal glands has brought about pressure upon one main bronchus, or in the worst instances, upon the lower trachea.

Compression of the recurrent laryngeal nerve upon either side, or of the vagus, is accompanied by exaggeration of the cough, with hoarseness, stridor, or inspiratory dyspnea. Irregular, slow or rapid pulse may result from compression of the vagus. A decided increase in the amount of expectoration suggests that the growth is breaking down. The greenish discoloration occasionally seen is probably due to gangrene in a compressed lung and is of very bad significance. Particles of the tumor may be recovered from the sputum.

Dysphagia is an occasional symptom—due either to pressure upon the esophagus or to involvement of the nervous mechanism.

Irritation of the sympathetic may cause contraction of the pupil, with flushing, while more complete compression of the nerve many result in pallor of the face and neck, and dilated pupil.

In cancer of the right lung, especially, the superior vena cava may be compressed, with edema of the body above the waist line. Dilatation of the external veins of the chest often follows compression of the internal mammary vein.

Physical Signs. Changes in the percussion note may not be manifest until the growth assumes such size as to give rise to dulness, or the presence of a pleural effusion causes flatness over the affected area. The most notable flatness is found in case of extension to the pleura, where solidified lung, vastly thickened pleura and perhaps a small effusion unite to produce phenomenal solidity, as in 4 of our recent cases. In one of these the right side of the chest was greatly enlarged. Flat tympany or hyperresonance may be found when a bronchus is compressed, or an amphoric note, if a cavity develops. The possibility of pneumothorax must be considered, although it is a decidedly rare occurrence. Displacement of the heart and mediastinum, which should be carefully sought for in every case, is usually due to effusion, but, as in one case of mine, may be due solely to the massive character of the growth in the lung and pleura.

Upon auscultation, we may hear pleural friction, bronchial respiration, decreased respiratory murmur, moist or wheezing rales, increased or diminished voice sounds or amphoric sounds, all interpreted precisely as in other lung affections. The heart sounds are frequently heard with unusual distinctness through solidified lung or pleura, or an effusion. Vocal fremitus is increased or decreased as in other conditions, and has no especial significance. The wide transmission of a blowing sound originating at a point of narrowing of a bronchus, from compression, commonly by a cancerous bronchial gland, is occasionally noted—the cornage of French writers. Pleural effusion probably occurs in half the cases, and is generally yellowish or bloody. Because of cancerous involvement of the pleura, which itself gives rise to extensive dulness, it is often less in amount than expected from the physical signs. The effusion may become purulent. Pericardial effusion may occur. The withdrawal of a small amount of bloody effusion in any case strongly suggests malignancy.

Diagnosis. In fairly typical cases we may expect a slow onset, with dry cough, slight sputum, later sanguineous, and still later, frankly bloody and gelatinous. As the disease advances, pain, fever in half the cases, loss of flesh, and the appearance of such physical signs as we have mentioned should strongly suggest malignant disease. The appearance of palpable glands about the neck or axillae, noted in many of the cases, is extremely suggestive, and the withdrawal of a bloody exudate from the pleura establishes a presumptive diagnosis. The finding of roentgenological evidence such as we have mentioned ordinarily clears up all doubt. The histological examination of an excised gland is conclusive, and should be carried out in most cases.

When the history and the presence of enlarged glands suggest tuberculosis, the sputum should be examined with especial care. The finding of bacilli does not in the least controvert a diagnosis of malignant disease, since, as we have seen, tuberculous processes so commonly serve as a starting point for the growths we are considering. Yet—such a finding calls for a careful sifting of all evidence before making a diagnosis of new growth.

Fishberg rightly speaks of the rarity of pain and dyspnea in early tuberculosis, but these symptoms are common in cancer. The nodules shown upon the *x*-ray plate in miliary distribution of cancer are larger and more dense than those of tuberculous origin. The absence of fever suggests cancer rather than tuberculosis, although, as noted above, half of the cases of cancer run a febrile course.

Because of the resemblance of syphilitic infiltration of the lung, a Wassermann test should be made in every case. Leukemic infiltration may be definitely recognized by the blood examination, and Hodgkin's disease by the characteristic distribution of the glandular involvement. Histological examination of an excised gland makes the diagnosis positive. The free use of the exploring needle is advisable in case of doubt as to the presence of empyema or pleural effusion of non-malignant character. The history, the febrile course, the expectoration and the *x*-ray appearance should readily serve to differentiate lung abscess. In a recent Denver case, an aneurism was found at post-mortem examination after a diagnosis of malignant disease had been made. Certainly, in most instances, the presence of a Wassermann reaction, of arterial changes, of accompanying aortic disease, tracheal tug, expansive pulsation, demonstration of pulsation by use of the fluoroscope, and the clearly outlined characteristic mass upon the *x*-ray plate will serve to prevent this error. The finding of the tracheal diastolic shock described by one of us[2] should absolutely exclude solid tumor.

In one case, thoracic aneurism and a mass from cancer of the esophagus were present at the same time giving a very confusing picture clinically as well as roentgenologically, yet the diagnosis was possible.

Jacobaeus produces an artificial pneumothorax before raying the chest, and is enthusiastic as to the results. Such a course is, in our opinion, rarely called for.

Complications. We have mentioned bronchiectasis and hemorrhage. A recent case died suddenly apparently of pulmonary embolism, but we had no opportunity to prove it by autopsy. Thrombosis of the vena cava and the various nerve involvements have been considered. Herpes zoster occasionally develops along an intercostal nerve compressed by the growth. Gangrene, atelectasis, metastasis and even external perforation may occur.

The prognosis speaks for itself, although we admit the possibility of surgical cure in rare cases in the future. The average case dies in twelve to eighteen months, but certain cases, perhaps, especially spindle-celled sarcoma, may last five years.

Malignant Disease of Pleura. We have considered the condition as a late development in affections of the lung. As a distinct disease it is commonly unilateral. There are the usual symptoms of pleurisy, pain, cough, dyspnea and loss of weight, generally without fever or expectoration. The needle passes with difficulty through the leathery pleura, and commonly withdraws but a small amount of bloody fluid. The density of the shadow upon the *x*-ray plate in cases of great cancerous thickening of the pleura is rarely surpassed by any pathological conditions. The development of inoculation metastases along the needle path gives opportunity for a conclusive histological diagnosis.

---

[2] Dr. Hall. *Am. J. M. Sc.*, Jan., 1900.

In one of our cases, these developed after every aspiration. The disease spreads by metastasis to the lungs and to surrounding lymph-nodes. After tapping, the displaced heart rarely returns to its normal position, because of the infiltration around it, and little relief is experienced from removal of fluid in the average case. The walls of the cavity involved are inelastic, and the removal of fluid leads to further hemorrhage, so that the fluid often becomes more bloody with successive aspirations. Little is commonly gained by this method of treatment.

In a case which has never been tapped, a yellowish, serous fluid may be obtained upon aspiration, but this need not prejudice us against the diagnosis of malignant disease. A bit of tissue which may be utilized for examination may be found in the needle. Endothelial cells, or even distinctive malignant ones, may be present in the fluid.

Secondary malignant disease of the pleura is vastly more frequent than primary, the source being generally cancer of the breast, stomach or mediastinum. Sarcoma is less frequent than cancer. The average case does not live a year.

Mediastinum. Malignant tumors of the mediastinum arise primarily from the mediastinal glands or from the thymus gland, in the great majority of cases. An aberrant thyroid gland may be the point of origin. Cancer of the esophagus develops a mediastinal tumor, either from the esophageal disease or secondary adenitis. Sarcoma in one of its forms is the most frequent of mediastinal growths. Lymphosarcoma, Hodgkin's disease and leukemic growth are not infrequent. Teratomata are rare. Secondary growths are common from any neighboring malignant affection.

The symptoms are those of pressure rather than of invasion of neighboring tissues. Cough arises when a bronchus is compressed and irritated, or the recurrent laryngeal nerve affected. Expectoration is less notable than in the chest involvements already considered. It may become bloody. Dyspnea appears when the trachea or the bronchial tree suffer from compression. It is often paroxysmal. In our experience, terrible paroxysmal attacks of dyspnea are much more characteristic of mediastinal tumor and aneurism than of any of the other conditions we consider. The sudden expansion of the aneurism under vascular stress, or of the tissues of the mediastinum, provokes even a fatal dyspnea. One of us[3] saw with the late Dr. E. P. Hershey, a case of gumma, presumably arising from the mediastinal glands, and proved by post-mortem examination, which pulsated so freely that we at first believed it to be an aneurism. In a pregnant woman seen with Dr. H. R. McGraw, death occurred during labor from suffocation, due to sudden hemorrhage into the thyroid gland, in part of substernal situation.

Phillips quotes a case of compression of the aorta by a mediastinal tumor, with gangrene of the lower extremities. Stridor, aphonia, sympathetic nerve disturbances, dysphagia, enlargement of veins, cyanosis, localized edema, secondary adenitis, pupillary signs, recurrent paralysis, pleural effusion, and most of the percussory and auscultatory signs already considered, may be found. Certain signs are more characteristic of mediastinal growth, especially deviation of the trachea, fixation of the larynx, compression of the spinal cord, the appearance of a palpable tumor at the sternal notch, marked dysphagia and great wasting. The deformity of the sternal section of the chest wall is common to sarcoma, aneurism and Hodgkin's disease, and erosion may occur in any of them, but is least likely in sarcoma. The pain is generally less severe and "boring" than in aneurism. The sitting posture, as the disease advances, leaning forward with head perhaps thrown backward, is distressing even to the observer. Cachexia is marked in many cases.

---

[3] Dr. Hall.

As a rule, tumors showing in the anterior mediastinum are sarcomatous, those in the posterior space being commonly tuberculous, especially in children. An invasive growth is more likely to be carcinomatous than sarcomatous in character.

The outline of mediastinal tumors is usually sharper than that of growths in the lung. Abscess is ordinarily distinguishable by its etiology, its febrile course, and high leucocyte count. The needle may be decisive. Some of the worst abscesses have arisen from perforation of the esophagus by bones and other foreign bodies, or have been associated with empyema, being, in fact, cases of mediastinal empyema. These cases have been more frequent since about 1917.

Dermoid cyst can rarely be diagnosed unless shadows of teeth can be obtained, or, as in a recent case in St. Joseph's hospital, sebaceous material and hair are coughed up. In case of doubt, repeated *x*-ray examinations may show the growth of a malignant tumor. The Wassermann test is imperative.

These cases are generally fatal in from six to twelve months. We showed a case of spindle-celled sarcoma, proved by histological examination of an excised gland, in four successive annual clinics at the Denver City Hospital, but such a duration is exceptional.

In conclusion, we should state that metastasis of malignant tumors to the chest is so common that roentgenological examination of the thorax before operation of such cases is as necessary as the customary palpation of the liver for metastatic nodules.

We have said little of treatment. Unless the growth can be checked in some degree by the use of the *x*-ray, we can offer but little hope.

DIAPHRAGMATIC HERNIA OF THE STOMACH

BY PEDRO L. FARINAS, M.D.

Roentgenologist to the Calixto Garcia Hospital

HAVANA, CUBA

THE case here reported is the only one known to me in the Cuban literature which has not only been diagnosed, but also operated upon and cured.

Male, aged twenty-four years, referred to me by Dr. Valentin Diaz of Ciego de Avila for roentgen-ray examination of the alimentary tract.

History. On February 2, 1918, he was wounded in the left thorax (infraaxillary region) through the sixth intercostal space. He had some cough and bloody expectoration, but the wound healed by first intention, and two or three months later he began to complain of digestive disturbances and pains radiating to the shoulder in the side wounded. His condition was getting worse; after February 4, 1921, he vomited very frequently, had hematemesis and melena and was not able to take any solid food; as a consequence, he lost weight and was very anemic.

X-ray Examination. Fluoroscopy. There was noted in the left side of the thorax and above the diaphragm a light shadow, dark and clearly visible, which changed with the respiratory movements. There was no displacement of any thoracic organ; the diaphragmatic movements were synchronous and somewhat reduced in the left side.

With the opaque meal it was noticed that the infradiaphragmatic part of the esophagus was turned upward to the left. The stomach began to fill abnormally, and was constricted in the cardia; the light shadow seen above the diaphragm was filled almost completely, and the stomach appeared in two sections limited by the constriction; one, supradiaphragmatic, which was the fundus and the cardia, and the other, infradiaphragmatic, which was the antrum pylori.

At the end of six hours the stomach was nearly emptied, and in twenty-four hours the head of the opaque meal was beyond the splenic flexure of the colon, which remained in the abdominal cavity.

Radiography. Figure 1 shows an hourglass form of stomach high up in the left chest; also the diaphragm dividing the stomach into two portions.

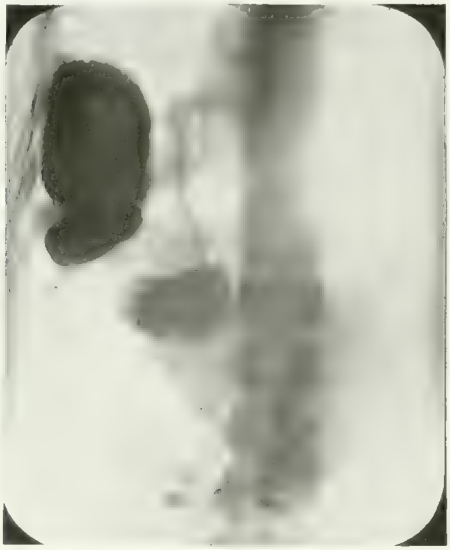


FIG. 1. Diaphragmatic hernia of the stomach.

Figure 2 shows the same stomach after recovery.

Operation. Dr. Felix Pages, surgeon to the Quinta de Dependientes, operated on the case and furnished the following information:

"Our technique was very simple. The incision extended from the ensiform appendix to the umbilicus. The opening through the diaphragm was thoroughly explored and extensive adhesions were found which were separated. This allowed the stomach to be returned to the abdominal cavity. The hernial ring was sutured without much difficulty. The air was extracted from the pleural cavity by means of a puncture through the sixth intercostal space in the axillary region. By the seventh day, the patient was eating without any trouble and a subsequent roentgenogram showed the stomach occupying a normal position.

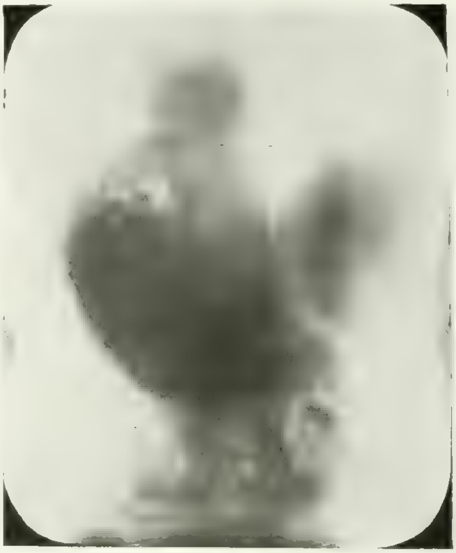


FIG. 2. Stomach after operation.

CONCLUSIONS

1. In some cases the symptoms cannot lead to the diagnosis, and the roentgen-ray examination is needful.

2. It is a good practice to inspect systematically the thorax in all cases of digestive tract screen-examinations.

SACROILIAC ARTHROSIS OBLITERANS*

BY EDWARD S. BLAINE, M.D.

Roentgenologist, National Pathological Laboratory; Consulting Roentgenologist, Cook County Hospital; Associate Professor of Roentgenology, Northwestern University Medical School

CHICAGO, ILLINOIS

INDIVIDUALS who seek medical relief for varying degrees of pain and discomfort in the lower back require careful *x*-ray study, as well as the usual clinical investigation, in the search for the cause of the symptoms complained of. During the routine examination of a large series of lower spine studies (approximately 1,800) a group of 18 was found to present unusual changes in the sacroiliac joints. These are the subject of this presentation. In these particular cases, the patients complain of a dull pain, and some soreness and stiffness of the back, with an uncomfortable feeling in the lower spine. These more or less vague symptoms in most of the cases came on gradually, and slowly increased in degree during a period of from several months to a year or more. The patients do not recall any particular time when the symptoms began. Injury to the spine has been ruled out in the entire group. A marked discomfort is noticed by nearly all the patients in the group under discussion, some of whom have had to discontinue their regular work, particularly those whose duties require them to stand on their feet or work at a bench all day. There are clinical evidences of a more or less degree of spinal rigidity, a considerable limitation of motion of the lower back, and a slight tenderness, which is fairly well localized over the sacroiliac joints and lower lumbar spine. In several of the cases, there is an obliteration of the normal lumbar curve. There is also found a slight to marked atrophy of the erector spinae muscles, sometimes unilateral, and often bilateral. The discomfort is found to be much increased when the patient has to sit on a hard-bottomed chair or similar unyielding seat. A jolting motion aggravates the symptoms. The condition is very slowly progressive and extends over a long period of time, with periods of comparative recession of the symptoms.

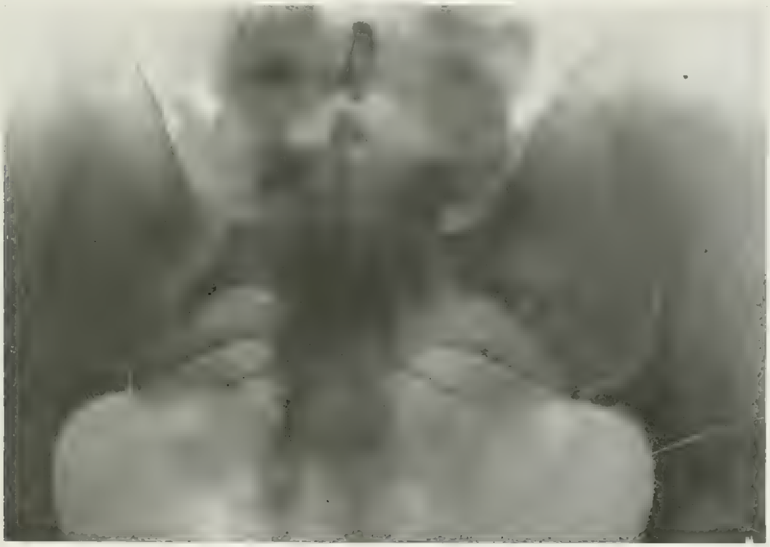


FIG. 1. Normal sacroiliac joints. Patient, male, aged twenty-six. Weight, 145 lbs. Presents average normal contour and sharp, smooth, regular shadows of all articular surfaces, with even interarticular distances.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

No rise in temperature was discovered in any of the cases.

The *x*-ray shadow manifestations of the condition under discussion represent gross intrinsic joint changes in the sacroiliac synchondroses. The majority of cases are definitely bilateral in involvement, but some are found to be unilateral sacroiliac conditions. Obviously, intimate or microscopical changes cannot be demonstrated by the *x*-ray plate regardless of wealth of shadow detail or excellency of stereoscopic effect, a fact which prevents conclusions being arrived at as to the precise pathology present. In several of the cases observed, there have been similar joint changes in the lumbar and dorsal joints, but this exposition concerns those cases in which the sacroiliac lesions are the most striking features.

The essential alteration is found to be a combination of destructive and constructive changes, sometimes both being present simultaneously. The *x*-ray features seem to indicate to the essayist a very low-grade type of joint infection of marked chronicity. Some of the cases present shadows that apparently indicate active changes, while in others the shadows appear to indicate inactive or healed stages of a joint disease.

A brief consideration of the shadow appearances of the normal sacroiliac joints, as compared with the shadows of the condition under consideration, will reveal that the former has a rather constant appearance in average normal individuals, and can easily be recognized as such in practically all cases which are exposed with the patient in supine position, and anteroposterior projection of the ray. In the normal adult it will be observed that the edges of the articular surfaces are well defined and sharply bordered at anterior margins of the joints, and the interarticular distances are even throughout and of uniform degree of shadow. Both the sacral and the iliac surfaces follow each other from upper to lower margins of the joint. This joint is peculiar in its anatomy, in that its general direction extends from behind, forward and outward, varying in degree of angle with the build and sex of patient. The anterior joint line, in general, is from above downward, parallel to the vertical axis of the body. The line of articulation is usually curved outwards, the upper and lower points being approximately equidistant from the median line. The posterior articular edges of the joint are seen mainly in its lower half, the upper

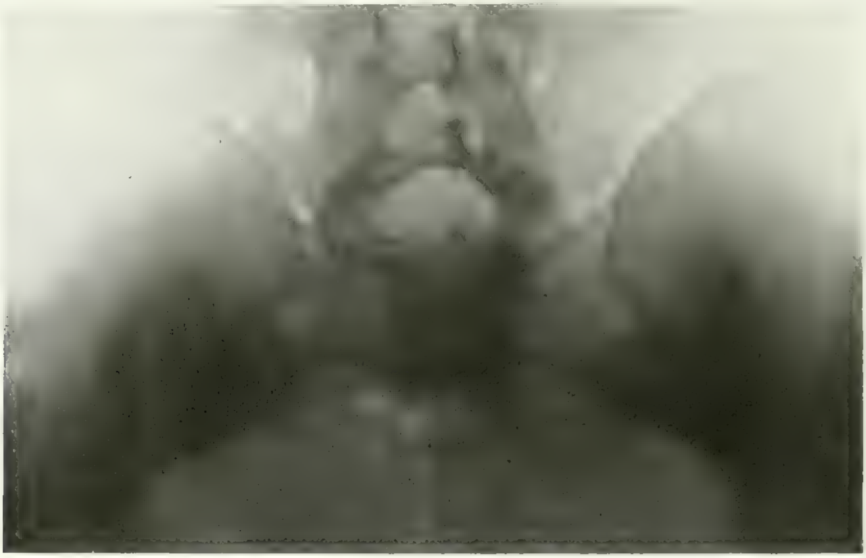


Fig. 2. Patient, male, aged twenty-six. No direct history of sacroiliac disease; complains of low-back pain. *X*-ray reveals bilateral obliteration of sacroiliac joints, total loss of articular surfaces, fusion of sacrum with both ilia, evidently the result of low-grade joint infection.

portion failing to give a definite joint-line shadow in most cases, because this portion is more nearly at right angles to the line of *x*-ray; that is, it faces anteriorly, and thus no shadow of its surface is obtained.

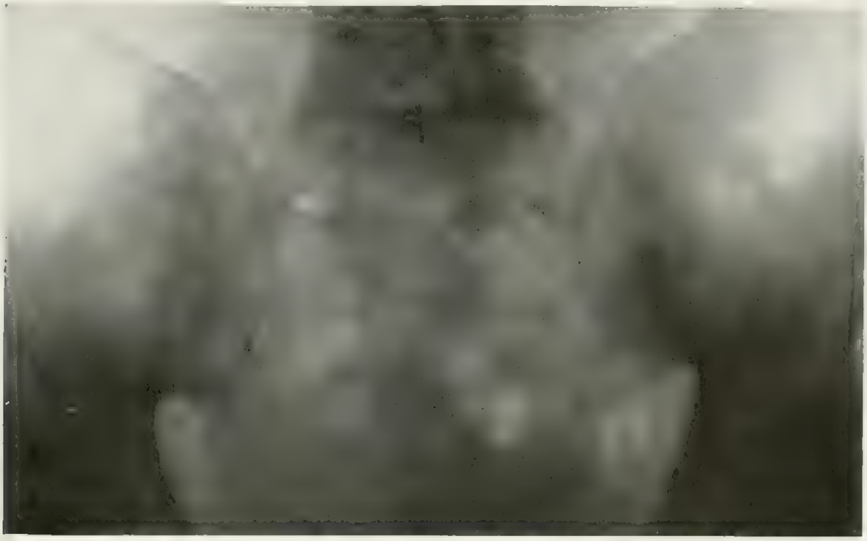


FIG. 3. Patient, male, aged twenty-nine. Complains of stiff back. No history of localized joint infection. *X*-ray reveals bilateral total loss of articular surfaces and resulting synarthrosis. This is a frequent sequence of a joint infection in which destruction of articular surfaces and interarticular structures occurs.

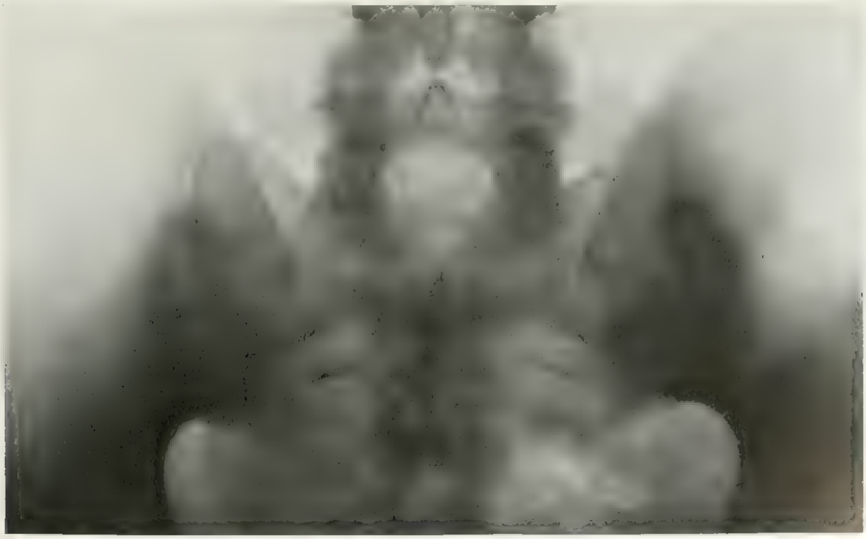


FIG. 4. Patient, male, aged twenty-three. Complains of pains in back; indefinite and not localized. *X*-ray reveals complete loss of both sacroiliac joints (total obliteration); sacrum and both ilia are one bony unit. The changes represent a previous joint infection in which a destructive process occurred.

An early disease in the joint may be deduced by a comparative decrease in the sharpness of the joint edges, these appearing to be somewhat hazy in shadow detail. This may be said to be due to localized edema and swelling of the articular surface tissues as well as the interarticular cartilages, which cause the loss of sharp shadow detail through "scattering." A further advance of disease in the joint is manifested by shadows which indicate an erosion of the articular surface edges, which normally are uniform throughout, the interarticular distance now being apparently increased. In no instance was the bony erosion seen to invade deeply into the underlying cancellous bone. A still further advance is shown by a material decrease in the interarticular distance between the sacrum and ilium as the two opposing surfaces approach each other,

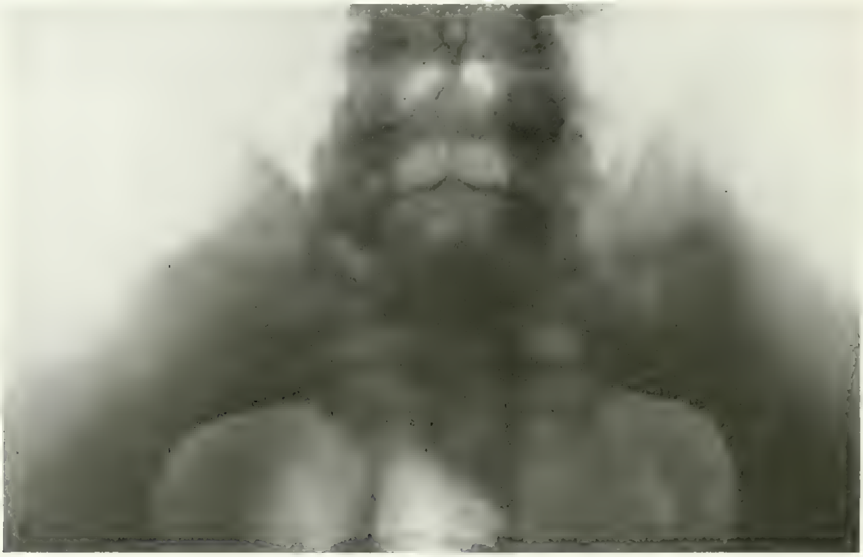


Fig. 5. Patient, male, aged twenty-seven. Complains of "dull pain in lower spine"; came on gradually during one and a half years. No history of sacroiliac disease. *X*-ray reveals bilateral obliteration of sacroiliac synchondroses, the destruction of articular surfaces, undoubtedly the result of a joint infection.

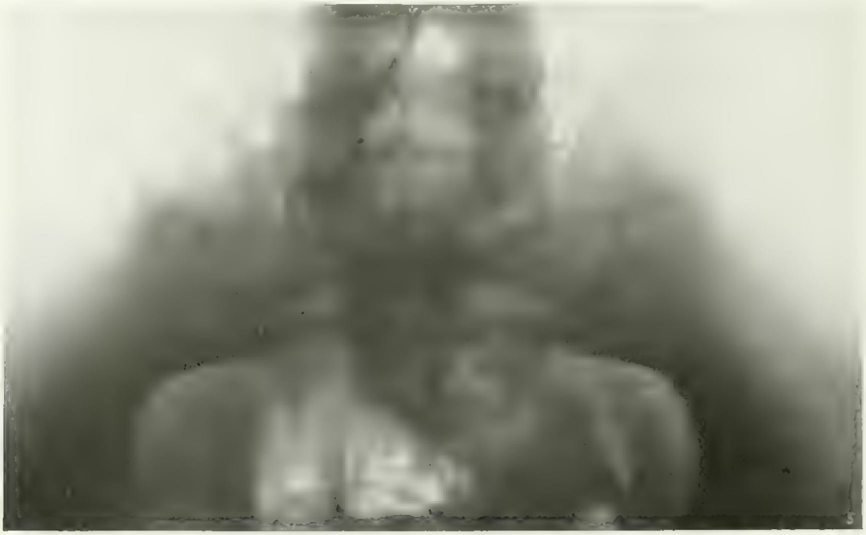


Fig. 6. Patient, male, aged thirty-one. Vague history of pain and discomfort in back. No injury or pathology of sacroiliac region. *X*-ray reveals complete loss of both sacroiliac joints, usual shadow evidences of destructive joint process and infection of articular surfaces.

because of loss, through absorption, of the intervening cartilage which has been softened through disease and which eventually disappears, thus permitting the two bones to come into direct contact with each other. At this stage, the joint condition is easily demonstrated by the *x*-ray shadows. An advanced case will reveal a total obliteration of the involved joint, a synarthrosis resulting, the two contiguous bones fusing into a single bone, in unilateral cases, while in bilateral involvement, the three bones join to form one single bony unit. In certain of the cases, a reparative process is conclusively established by shadows that represent a distinct hypertrophy of bone developing around the obliterated joint, and often extending into the soft tissues in the immediate neighborhood. It is a question whether to regard this hypertrophy as part of the sacroiliac lesion, or a manifestation of a concomitant hypertrophic osteoarthritis. This increased bone seemingly is an attempt on the part of nature to assist to immobilize the joint by an auto-splinting, as it were.

Viewed in certain aspects, the early changes are not dissimilar to some changes which are regarded as characteristic of osteoarthritis hypertrophica. In fact, the early stages of this condition are quite like an ordinary low-grade arthritic infection, and therefore cannot be distinguished or differentiated from it. The latter stages of this joint condition have a surprising similarity to the shadows that often are found in so-called "typhoid spine."

As every effect has a cause, one seeks to determine the reason for this particular sequence of joint change. The *x*-ray shadows do not establish just what this is; whether any particular microorganism, toxin or other irritative material is the cause has not been determined. One of the most striking features noticed is the fact that all the individuals in this group of cases are under thirty years of age, several being less than twenty-five years old.

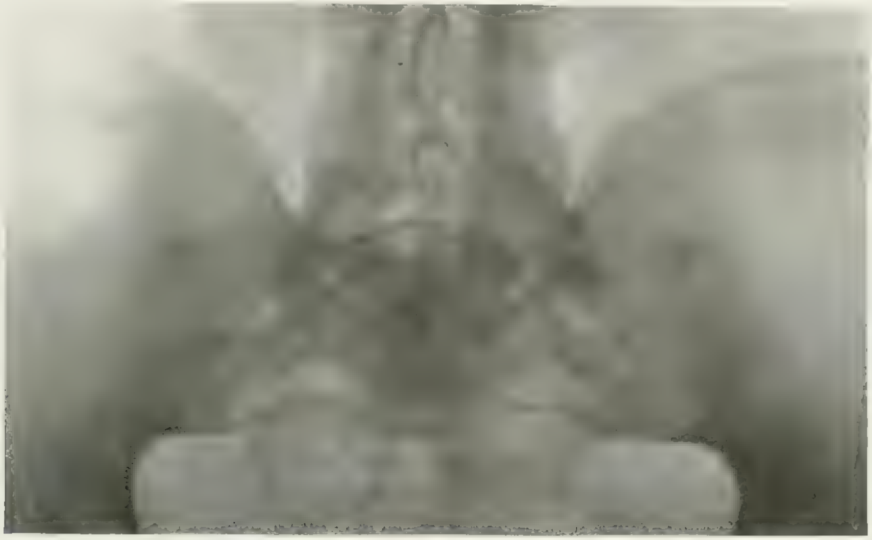


Fig. 7. Patient, male, aged twenty-eight. Complains of stiff back, no symptoms directly referable to sacroiliac region. No injury. *X*-ray reveals complete loss of both sacroiliac synchondroses. Sacrum and both ilia are fused into one bony unit. The shadows represent healed (?) stage of joint infection of articular surfaces and joint cartilages, synovia, etc.

DIFFERENTIAL *X*-RAY DIAGNOSIS

Viewing these cases from the standpoint of differential *x*-ray diagnosis, one will consider:

1. Typhoid arthritis.
2. Septic arthritis.
3. Chronic hypertrophic osteoarthritis.
4. Tuberculous arthritis.

The shadows found in so-called "typhoid spine" or typhoid arthritis present no essential differences from those observed in this series of cases, particularly in the latter stages. There is the same joint destruction and disappearance of interarticular cartilage, and at times a reparative process around the joint. The history, therefore, is an important point, and will greatly assist in the study. No history of clinical typhoid fever was found in any of the cases of this series.

In septic arthritis, the amount of joint change usually depends on the virulence of the invading microorganism and, if severe, will result in a complete joint obliteration, or synarthrosis. I have seen similar joint disappearances follow in a case of puerperal sepsis, the infection having reached every joint below the dorsal spine, without exception.

In cases of chronic hypertrophic osteoarthritis, there is little or no destructive change of the internal joint structures, and this disease is essentially a matter of bone-tissue increase at the edges of articular surfaces. The joint immobilization is present only in the extreme type of this condition, namely, arthritis deformans. Here, too, the articular surfaces present much less change, and the alteration is not that of erosion with absorption or disappearance of the articular surfaces, as is the case in the arthropathy here presented. Then, too, the changes in chronic hypertrophic osteoarthritis occur in many of the joints simultaneously, though not always in the same degree; whereas, in the condition under discussion, they involve usually but one or two joints. Chronic arthritis is seldom found in individuals under thirty-five to forty years of age; while our cases are all in the third decade, that is, between twenty and thirty.

Tuberculous arthritis of the sacroiliac joints is seldom bilateral, and it also differs from the changes here described in that there is a rather extensive softening of the cancellous bone tissue in the bones surrounding the involved joint, and there is usually a far greater destruction of bone than has been observed in the cases under study. The end result of a healed joint tuberculosis often is a synarthrosis, but there is much more alteration in the joint relations of the bones than is the case here.

Further investigation as to the etiology is in progress, and it is hoped that this preliminary study on sacroiliac joint obliteration may be followed by one in which a more definite cause can be presented to explain this unusual arthropathy.

THE VALUE OF GRANT'S PINS IN THE OPEN TREATMENT OF FRACTURES AS SEEN ROENTGENOLOGICALLY*

BY D. Y. KEITH, M.D., AND J. PAUL KEITH, M.D.

LOUISVILLE, KENTUCKY

DESCRIPTION

THE gimlet device (Fig. 1) consists of a shaft made from an ordinary wood screw 5 to 10 cm. in length and 2 to 3 mm. in diameter on which a handle is firmly fitted at right angles. The handles are 5 to 8 cm. in length and 1 to 2 cm. in breadth.

A narrow slit in each handle allows of secure locking together by a screw and tap. The screws are placed 3 to 4 cm. from the line of fracture, one screw to each fragment.

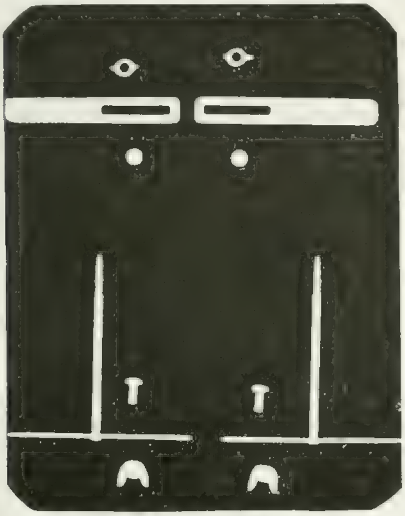


FIG. 1. Shows Grant's gimlets in two directions, showing screws and slots in which they fasten.

The handles are then overlapped and firmly locked with the screw and tap. The gimlets are made in several sizes, to accommodate the smallest forearm or the largest femur.

HISTORY

Grant's gimlets were first used by the late Dr. H. H. Grant in 1915, and a report of 8 cases so treated was made in 1917, in which he obtained good results. Since then, several scores of cases have been treated in our local hospitals by numerous operators, some of whom do very little surgery.

Practical Surgical Points. The most important point is that the screws should go through the medullary canal and enter the opposite side of the shaft. Another point is to have the screws made of better metal than an ordinary wood screw; otherwise, the tip of the screw may break off in the bone. The juncture of the screw shaft to the handle should be heavy, forming a square shoulder to prevent rocking of the gimlets. The drill-holes should be of the same size as the gimlets.

In all the cases which we have seen, the reductions have been very good, the approximation perfect in many of them, though it was the operator's first use of gimlets. If the reduction is so good in inexperienced hands, it must be very easy to do. In the hands of a real general surgeon, the approximation has been excellent. To our knowledge, no amputation has been necessary, following the use of the gimlets.

This, we believe, is a better record than has been achieved with the use of Lane's plates or any other open operation. Had any of you observed the many perfect reductions we have seen in badly displaced fractures, some of them compound, with restored function free from infections, we believe you would feel it your duty to suggest a trial of this method to your surgeons in your next case in which they have failed by traction, manipulation, etc., under general anesthesia, to reduce a displaced fracture of some of the larger long bones.

In the young or muscular individual, fractures of the surgical neck of the humerus, and transverse fractures in the middle portion of the humerus where there is marked displacement prove irreducible by the closed method. You have all seen these cases return two or three times for re-examination, with increase in the overlapping or displacement and sometimes both, after much time had been spent

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12 16, 1922.

under anesthesia in attempt at reduction. All experienced surgeons and roentgenologists recognize the impossibility of satisfactory reduction in these cases by the closed method, but invariably recommend at least one attempt under anesthesia.

All of you recognize as irreducible by any closed method, transverse fractures of the femur at the junction of the upper and the middle thirds, in the central portion of the bone, or a few inches above the knee-joint when there is a few centimeters' separation of the fragments by intervening muscle and fascia. Many of these cases have such a thick piece of muscle and fascia interposing that it is impossible to obtain true crepitus.

Fig. 2. Fracture of the surgical neck of the humerus, with axillary displacement of the upper end of the lower fragment and rotation of the head.

This is the type of fracture in which we see non-union or delayed union, as it is impossible for callous union of the fragments to occur until there has been a perforation of the impinged muscle and fascia. We feel that, in this type of fracture, our responsibility in interpretation is to insist upon an open gimlet operation as the safer and surer method, involving very much less trauma to the impinged soft tissue. Trauma means devitalized tissue, which invites infection.

We have seen but one or two closed reductions in the true transverse type of fracture of the femur in any of the above locations. One of these showed on the roentgen film a perfect reduction, made after the application of plaster of Paris, that later slipped, giving a poor result, with much chagrin to the attending surgeon. The efficiency in maintaining fixation is one of the gimlet's great assets. We all know how very little force it requires to hold a fracture in alignment, in any open method, yet how a little movement can easily displace it.

Roentgenologically, we can recognize the fractures in the central portion of the humerus, femur, etc., in which the soft structure between the fragments prevents reduction by any closed method. If we have an ideal, or at least, a satisfactory open method that can be conscientiously recommended, may we not insist upon its application? As roentgenologists we can serve many more people than several surgeons, as our opportunity for seeing a great number of fractures surpasses that of any surgeon.

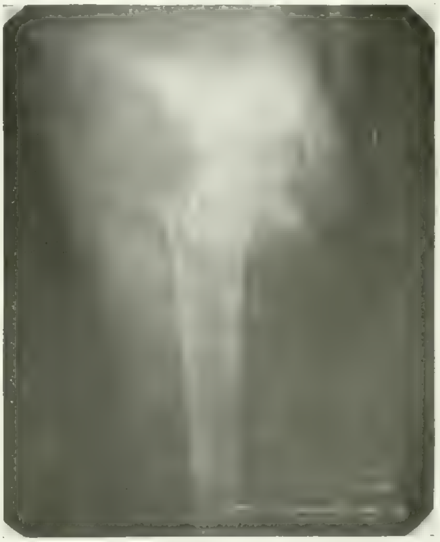


Fig. 3. Buck's extension with the arm at right angles to the shoulder.

It has been our good fortune to assist in a great number of gimlet operations, to see the real conditions present and the ease with which they are secured after reduction has been accomplished, as well as their efficiency in maintaining reduction.

It is needless to say, rigid aseptic technique is required as in any bone surgery. When this has been obtained we have yet to see an infection occur following the use of the gimlets in simple fractures.

In many of the compound fractures where an early operation was done, infection has not appeared. The removal of blood-clots and devitalized tissue prevents infection, and the screws certainly promote drainage.

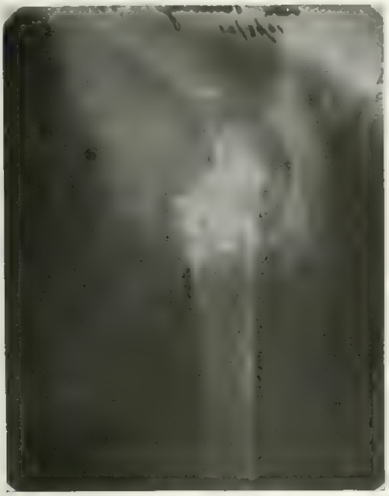


Fig. 4. Third attempt with Buck's extension with arm upward.

Two case reports with slides will suffice to show the advantages of the method, as well as the fruitless attempts at reduction of certain fractures by the closed method.

Case I. Male, aged thirty-two. Received a fracture of the surgical neck of the humerus when his automobile was overturned. A diagnosis of dislocation of the shoulder was made and reduction performed and verified by fluoroscopic examination by a near by mining-camp surgeon. Not being thoroughly satisfied, the patient came to us ten days after the injury and, on roentgen stereoscopic film examination, we found a transverse fracture of the surgical neck of the left humerus with displacement of the upper end of the lower fragment upward and inward to the axilla. The upper fragment was rotated outward and upward (Fig. 2).

Reduction was attempted by using a Buck's extension first in a downward and outward direction (Fig. 3) then in an outward direction nearly at right angles to the shoulder-joint (Fig. 4). The third attempt was upward, the arm being extended (Fig. 5). At each attempt at reduction the position of the fragments was not improved, but showed greater angulation as well as overlapping.

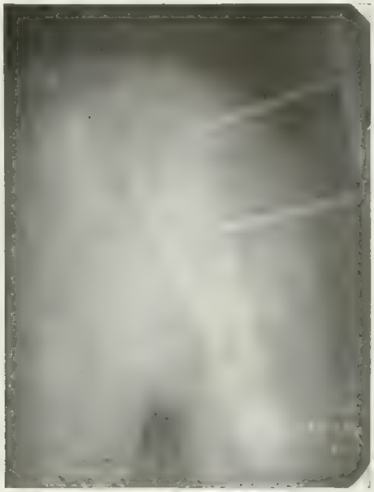


Fig. 5. Perfect reduction with Grant's gimlets *in situ.*

An open operation was performed three weeks after injury by Drs. E. S. Allen and W. E. Fallis, and it was difficult to separate the fragments on account of so much callus. Reduction was finally obtained and maintained by gimlets (Fig. 6).

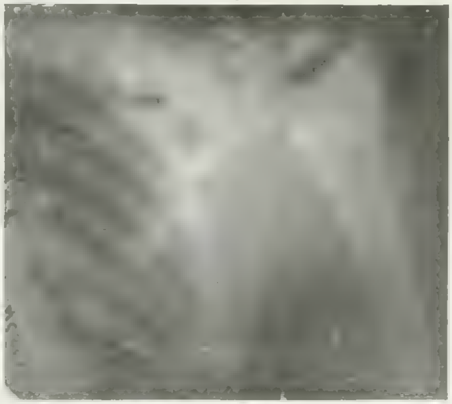


Fig. 6. Final result. Note the moderate amount of callus and very little bone atrophy.

Nearly complete function was present in two months' time with all the movement of the shoulder-joint except extreme extension. Roentgenograms since then (Fig. 7) show very little bone atrophy or change in the periosteum at the site of the gimlet

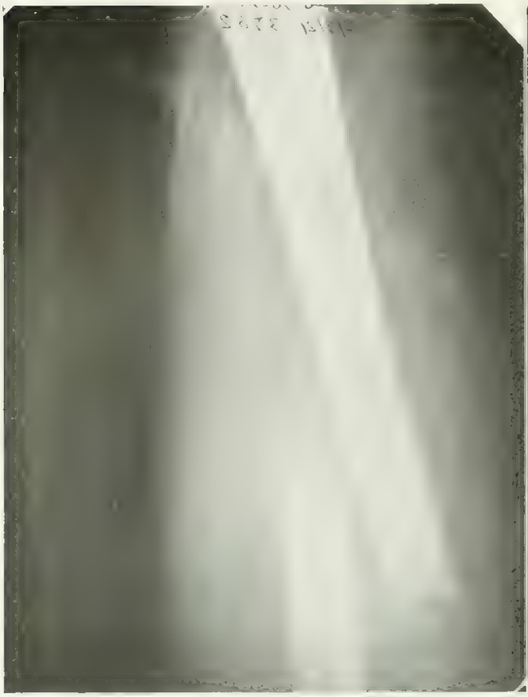


FIG. 7. Transverse fracture of the femur. Central portion after three attempts at reduction by closed method with and without anesthesia.

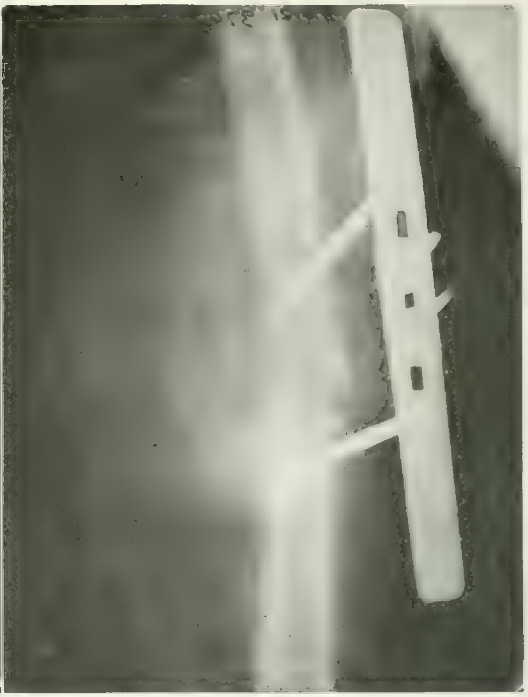


FIG. 8. Same as Figure 7 after fixation with Grant's gimlets by open method.

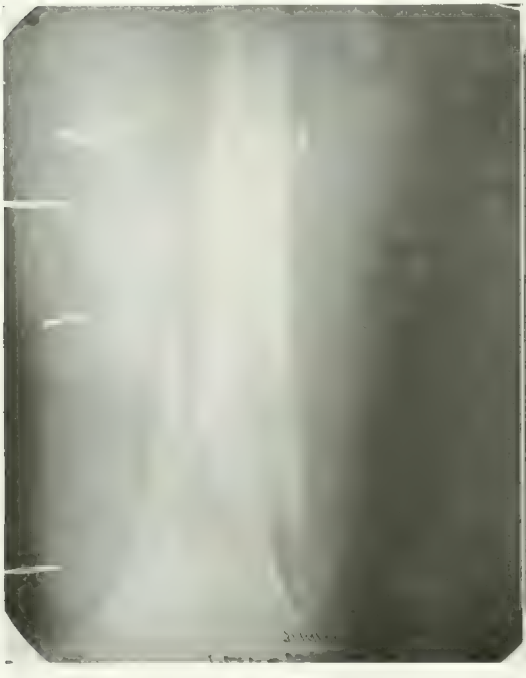


FIG. 9. Shows double transverse oblique compound fracture of the femur, received by a kick from a horse.

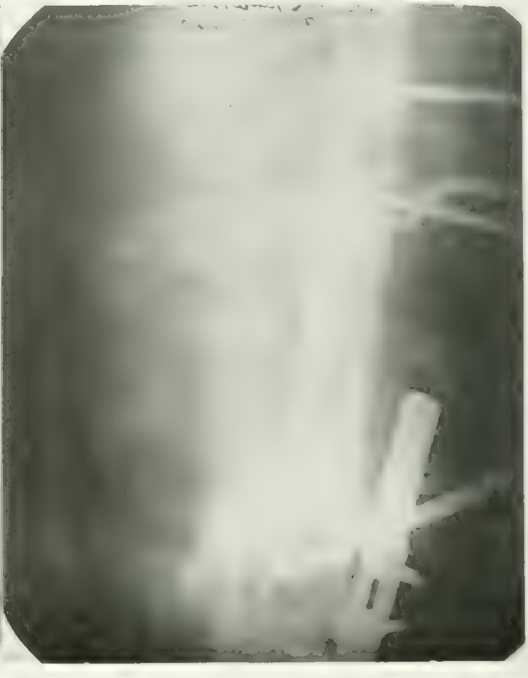


FIG. 10. Same as Figure 9 after reduction with Grant's gimlets, and with rubber tubes inserted for drainage.

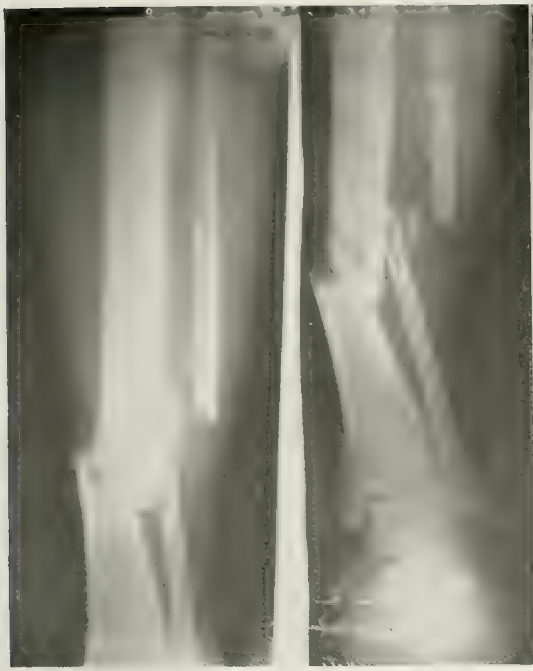


Fig. 11. Shows transverse oblique fracture of both bones of the leg with marked displacement.

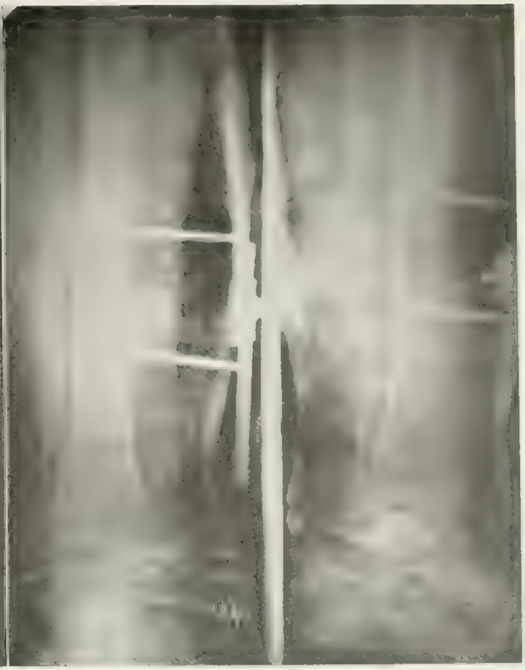


Fig. 12. Same as Figure 11 after fixation with Grant's gimlets.

implantation. The patient has complete restoration of function.

Case II. Male, aged seventeen. Received a transverse fracture of the right femur at the middle and upper third with displacement, 2 in. overlapping, and angulation at the site of the fracture. The first reduction was attempted under general anesthesia, using a Hawley table. The second attempt was with a Buck's extension with roentgen-ray examination in bed. The third attempt was with the leg in a double inclined plane with Buck's extension; displacement, angulation and overriding were not improved (Fig. 8).

Perfect reduction was obtained and maintained by the open method and the use of Grant's gimlets (Fig. 9).

The chief advantages of this method of open operation are:

1. The ease of application; the line of fracture need not be touched.
2. So little manipulation is required that the possibilities of infection are greatly reduced.
3. The gimlets are an aid in, and are efficient in maintaining, reduction.
4. External control of internal conditions.
5. Ease of removal; no anesthetic required.
6. No trauma in removal, with freedom from infection.

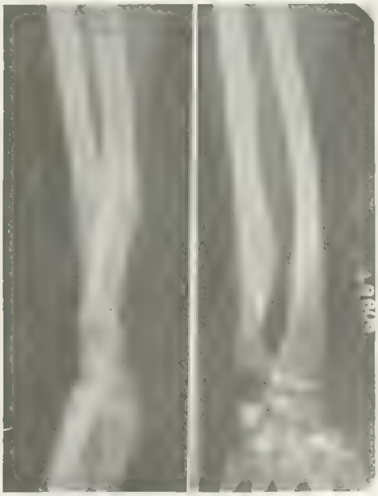


Fig. 13. Shows forearm five years after fixation with Grant's gimlets for a transverse fracture of both bones of the forearm.

7. Can be used early in compound fractures.

DISCUSSION

Dr. Davis. I would like to know if Dr. Keith puts extension on when these pins are put in; and if you can get enough extension to bring the bone ends together, why is it necessary then to put the pins in?

It has been my observation where we have put pins in, for example, through the os calcis and fractures low down in the tibia and fibula, it is not infrequent to get infection. We do get infections, and if we can get enough extension down on the long bones, would it not be well to keep it there with the extension rather than put in a foreign body? I would like to know if Dr. Keith has had any difficulty or complications.

I have had occasion to see quite a few fractures and my experience is that the more operative bone work I do the greater the number of complications. I would like to know how Dr. Keith gets the lower end of the femur back into place when he puts these pins in. It seems to me that if we could get the fracture into position by extension and put the patient in a modified Thomas splint, that it would hold it there without pins. I would like to know if he has had any complications in regard to the use of pins.

Dr. LeWald. Dr. Keith talked this over with me and I was interested in the subject.

In the use of the Steinman pin or traction by means of tongs, the danger of a bone operation is much less because it is a simple incision through the skin, and in my experience I have seen results just as good as from this method Dr. Keith has illustrated. As seen in his illustrations in the upper extremity where one cannot use this tong method to advantage, I think the results as shown are certainly very remarkable, and the method must have its use in that type of case, but I think that in the lower extremity regions a more simple pin or tong application is sufficient.

Dr. Childs. In the very extensive field that is occupied now by *x*-ray diagnosis, it seems to me that the field of fractures has been somewhat overlooked in its importance as Dr. Keith has mentioned.

I am not familiar with the Grant pins but have had an opportunity to examine by the *x*-ray the end results obtained in fractures after their reduction by the Freeman modification of the Parkhill clamp.

This modified clamp works on somewhat the same principle as the Grant pins, and can be used for the reduction of the fracture by the open method under direct inspection as described by Doctor Keith. In certain cases the fracture is not exposed, as a small incision above the fracture permits one screw to be inserted into the bone and through a similar incision below the fracture another screw is inserted, and when the clamp is attached to these screws sufficient extension can be obtained to adjust the fracture into satisfactory alignment.

I think Dr. Keith is entitled to the thanks of this society for calling our attention to the efficiency of the Grant pins in the reduction of fractures requiring an open operation.

Dr. Keith (closing). The type of fracture in which this method is indicated is the case that has been manipulated two or three times and is still in the same shape or in worse shape than before manipulaiton was started. The type of fracture we show has been, in our experience, irreducible. Why not as roentgenologists recognize irreducible fractures and save the patient two or three anesthetics and much trauma?

We have seen several cases treated by the tong method and but few if any are infected. There isn't much danger of infection in the tong or Grant's gimlet operation if you have a real surgeon who knows bone technique.

THE EFFECT OF SMALL DOSES OF ROENTGEN RAYS IN CERTAIN FORMS OF IMPAIRED HEARING*

BY D. C. JARVIS, M.D.

BARRE, VERMONT

DURING the summer of 1921, a patient about forty years of age was treated by means of the roentgen rays for an enlarged lingual tonsil by Witherbee's technique, namely, a 7-inch gap, 5 ma., 10-inch distance, but using two minutes' treatment time, as it was the first treatment. The rays were filtered through 3 mm. of aluminum. By means of lead foil, other areas were blocked off except that overlying the lingual tonsil. One week later, the patient reported at the office, and volunteered the information that the right ear, which had been "stuffy" for ten years, was clear, and that hearing was improved. No great importance was attached to the statement, but one month later, having a patient who had appeared at varying intervals at the office for inflation of both ears by means of the Eustachian catheter, and not succeeding readily in restoring the hearing by means of the usual inflations, a trial of the roentgen rays was suggested, the area exposed for treatment being that recommended by Witherbee in treating tonsils. His technique with a two-minute treatment time was used, exposure being made from each side of the throat as if both tonsils were being treated. Two days later, the patient, who was the proprietor of a small general store in an adjoining town, returned to the office stating that his hearing was restored, the sensation of stuffiness in his ears was relieved, and that he experienced no difficulty in hearing while waiting on customers. From this statement, interest was aroused in this subject. Outside of the use of roentgen rays, my practice is limited to eye, ear, nose and throat; hence any agent that would improve hearing commanded my attention. As cases were treated, it became apparent that all patients complaining of impaired hearing were not improved. It was soon realized that the treatment was applicable only to certain types of patients, and an effort was made to discover the type of patient in whom the use of the roentgen rays would produce results.

There seem to be three classes of individuals complaining of impaired hearing. The first class includes children and young adults whose impaired hearing is so often explained by the presence of a mass of adenoid tissue in the nasopharynx. The second class includes individuals between the ages of twenty-five and fifty, who seem to be subject to frequent head colds, complain of a more or less constant catarrhal discharge from the throat, and at frequent intervals a stuffiness in the ears with an accompanying impairment of hearing. This type of patient appears at one's office at varying intervals for ear inflations, and often emphasizes the annoyance occasioned by head noises. The third class includes those who are advanced in years, and whose outstanding symptom seems to be impaired hearing with or without the accompanying head noises, less emphasis being placed on the throat symptoms. As one considers these three classes, the outstanding feature of the first is obstruction to nasal respiration, of the second, the throat symptoms, and of the third, simply impaired hearing. As observations were continued, it was noticed that the type of patient represented by class two, that is, the individual in whom the throat symptoms were usually a prominent part of the clinical picture, responded best to the use of the roentgen rays. A study of these individuals disclosed the fact that the inferior and middle turbinates were often increased in size, that there were present lymphoid nodules on the posterior pharyngeal wall, and often a prominent band of lymphoid tissue running up either side of the pharynx just posterior to the posterior tonsillar pillar. A study of the lymphoid tissue present in the throat following the use of the roentgen rays showed that in forty-eight hours it markedly decreased in size and redness, and with it the catarrhal discharge from the throat. It was concluded that the results obtained were due to the effect of the roentgen rays on lymphoid tissue. In one patient who was timid about the use of the roentgen rays an exposure of thirty seconds was given,

---

* Read by title at the Twenty-third Annual Meeting of the AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

producing the same results as with the two-minute exposure. As a result of this experience, various exposure periods were tried out, and at present one minute is being used. It hardly seems possible that lymphoid tissue can be influenced by a treatment of such short duration. The work of Witherbee, in which he and his colleagues report the results of bacterial studies, and the recent work by Hickey on diphtheria carriers cause one to lean towards the theory of the germicidal effect of small doses of the roentgen rays. For some time we have been familiar with the effect on the ears and throat of the cleaning up of a bad dental condition, and also the improvement in hearing following the removal of septic tonsils. In these two instances we have believed we removed the source of infection.

There is another effect of the use of small doses of the roentgen rays, and that is its effect on head noises. In the type of patient represented by class two, the treatments so far have not failed to give relief, and if no other results than the relief of tinnitus aurium were accomplished, the employment of the roentgen rays would be well worth while. Where head noises occur in the elderly type of patient represented by class three, their relief does not seem to be so often accomplished. I am unable to explain why, except that the throat element of the case is not so prominent. In the recent questionnaire sent out by the president elect, asking, among other questions, for information on the treatment of deafness by means of the roentgen rays, suggestion was made that the effect of the rays was on one of the endocrine glands. It almost seems as if the work of Witherbee and Hickey, plus the blocking off of the gland area by lead foil and the use of a treatment cone, pointed to an effect on the bacterial content of the throat rather than on the gland. In closing, one case will be reported, as illustrating what may be expected from the use of small doses of roentgen rays in aural disease.

Female, aged forty-four. The office record shows that the patient has been coming for ear inflations at frequent intervals since December, 1912. At this time, she stated that hearing had been impaired in the right ear for fifteen years, and that the left ear developed impaired hearing a few weeks previous to her first visit. As the dates of office visits are scanned, it is noticed that springtime represents the time of most frequent inflations of ears. This year (1922) she appeared at the office in February for a course of ear inflations, and the use of the roentgen rays was suggested. Four treatments were given: on Monday and Wednesday of the first week, and on Monday and Friday of the second week, the time being one minute for each side. Head noises, catarrhal discharge from the throat and stuffiness in ears were relieved. On May 18, 1922, the patient came to the office stating that she was just getting over a head cold and wished the roentgen rays used to stop the buzzing in her ears. At this visit she stated that no head colds had appeared since February until the present one in May, that now she was not bothered by drafts, and the head noises had been absent until the present buzzing appeared following the present head cold. Since February, she has been able to hear conversation much better, could hear the alarm clock tick as she moved about the room, and was able to hear the telephone ring. On May 18th, she was treated with the roentgen rays. On May 20th, she reported that the buzzing in her ears stopped one hour after the use of the roentgen rays and that hearing improved. She has been under my constant supervision since December, 1912, during which time she has had many inflation treatments by means of Eustachian catheter, but at no time, she states, has she been free from buzzing, sound of whistles or escaping steam, until the roentgen rays were used; and the office record bears out her statement.

SUMMARY

1. Small doses of roentgen rays are a valuable aid in treating aural disease.
2. They are most valuable in cases disclosing a prominent throat element.
3. It would seem that results are obtained by the roentgen rays influencing the bacterial content of the throat.
4. Their influence is most marked on tinnitus aurium, relief following soon after the treatment.

TREATMENT OF DEFECTIVE HEARING BY SMALL DOSES OF X-RAYS

BY JOHN McCOY, M.D.

NEW YORK CITY

The writer wishes to report the result of a series of cases of deficient hearing treated by the method proposed by Dr. Charles Stokes for the alleviation of this condition. The types of cases treated were embraced under the pathological conditions causing deficient hearing as follows:

Otitis Media Catarrhalis Chronica (O.M.C.C.) otherwise known as chronic dry catarrh.
Otitis Media Purulenta Chronica (O.M.P.C.).
Otitis Media Purulenta Residua (O.M.P. Residua).
Otosclerosis.

The majority of cases had had all foci of chronic infection removed, and had been placed on the other well-known methods of treatment before being subjected to the *x*-rays.

The method is employed as follows: The patient is seated 30 inches from the target and has the *x*-rays applied in turn to the regions of the right ear, left ear, the occiput and the open mouth in a direction toward the pituitary gland. A 110-volt current is used with a 4-inch spark-gap and from 5 to 10 ma. The exposure lasts from ten to thirty seconds laterally, from ten to twenty seconds posteriorly and from five to fifteen seconds anteriorly. An opaque shield with a perforation 3 inches in diameter is used laterally. The shield is held in front of the eyes for the anterior exposure. The treatments are given two or three times weekly for three to six weeks.

The cases were tested by the watch, acoumeter, voice and whisper, before and after the treatments. The patency of the Eustachian tubes was also specially noted along with the other usual notations of the condition of the nose, throat and ear. The results noted were placed in the following categories: Greatly improved, slightly improved, no improvement.

By "greatly improved," we mean a greater sensitization to the human voice and whisper, so that the patients were able to hear from five to six times further than before treatment; the improvement to the finer sounds of the watch, while slight, was mostly negligible.

By "slightly improved," we mean the patient was able to hear two to three times further than before testing.

A list is given of 45 cases treated, with the corresponding results:

O.M.C.C.	Greatly improved	9
	Slightly improved	19
	No improvement	7
O.M.P.C.	Greatly improved	0
	Slightly improved	2
	No improvement	0
O.M.P. Residua	Greatly improved	1
	Slightly improved	1
	No improvement	0
Otosclerosis	Greatly improved	2
	Slightly improved	2
	No improvement	2
	Total	45

In addition to the above, there was noted a decidedly greater patency to the Eustachian tubes in all cases in which there was a tendency to stenosis. In 2 cases, there was noted a decided improvement in the sense of smell. In 2 cases of hypertension there was noted a decided drop in blood-pressure. Tinnitus, which was present in most of the cases, was stopped in 6 and alleviated in 10 cases.

In conclusion, the writer believes that we have here a method which is still empirical, is not harmful and is in many cases beneficial. As to the theory of its action, the writer feels that there must be an absorption of small-celled infiltration in the Eustachian tubes and possibly at the terminals of the auditory nerve, as well as perhaps a stimulation of the same. Whether there is penetration to the pituitary gland is a question, but that some change takes place in it, is given food for thought by the alteration in blood pressure.

---

* Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

THE ROLE OF RADIUM NEEDLES IN THE TREATMENT OF NEOPLASTIC DISEASES*

BY WILLIAM L. CLARK, M.D.

PHILADELPHIA, PENNSYLVANIA

THOSE who have employed radium with due regard to established facts concerning the physics of the element, and who, by the study of authentic literature and sufficient clinical experience, have acquired a knowledge of applying it correctly, are profoundly impressed with its power for good in the treatment of malignant disease, and certain other pathological conditions.

While great strides have been made in an incredibly short period of time, toward increasing the sum total of knowledge concerning the physical properties of radium and the problem of its application to disease, we are not only justified in the belief that there is much yet to be learned concerning it, but that, with continued intensive study, laboratory experiment and clinical experience, radium will soon be shown to possess infinitely greater value as a therapeutic agent than is realized at the present time.

There are numerous ways and forms in which radium may be employed to meet the individual requirements of a case, and the ingenuity of those employing this agent is often taxed to the utmost to devise means by which particular indications may be met to the greatest advantage. Indeed, it is absolutely essential that this flexibility of application be recognized and practiced, with careful consideration of individual requirements, if the best results are to be obtained. A highly specialized instrument in the hands of one unaccustomed to or unskilled in its use might bring discredit upon the instrument and upon himself, while in the hands of an experienced and skilled workman the same instrument might be made to serve its purpose to the utmost of its possibilities, and establish the reputation both of the instrument and of the operator.

So, also, the reputation of radium has often suffered, not for lack of potential value, but by its unskilled use.

The therapist must, also, with broad vision, recognize the importance of other measures, such as operative surgery, electrothermic methods, and the *x*-rays, else he will not enjoy the same satisfaction of achievement as does he who recognizes and practices combined methods of attack.

One who, by writings and practice, makes pretension of treating malignant disease successfully, must acknowledge the importance of all units which have been shown, by critical tests, to be of value, else he will in time lose the confidence of his clientele and be outdistanced in achievement by the man who does his duty to his patients, to the medical profession, and to himself, by utilizing every means available to accomplish the desired results.

Of these means, not the least in value is the application of radium in needles, and it is to the consideration of this method that the present paper will be confined.

The introduction of radium needles marked an epoch in the usefulness of radium therapy, not only in the treatment of some forms of malignant disease in certain anatomical locations, but also, in some benign neoplastic conditions.

Over three years of study and varied clinical experience with radium needles have led me to the recognition of the following facts concerning this form of radium application:

When radium needles are introduced into neoplastic tissue the maximum reaction is obtained, owing, in the first place, to the direct action of the rays upon the tissue, and in the second place, to the cross-fire effect from needle to needle.

The total radiation from each needle can be utilized locally, in contradistinction to the extravagant dissemination in the air of approximately three-fourths of the radioactivity during surface application.

The corrosive action of the body fluids on the steel needles as originally provided, has been largely overcome by the use of nickel alloy. In some cases, however, platinum or irido-platinum needles are more desirable, although these are less durable, and bend more easily. In addition to the strength of the metal employed in the composition of such needles, an important factor is its property of filtering out the beta rays, or all but the hardest beta rays, depending upon the thickness and density of the metal employed. The fact that some of the beta rays are filtered out by the needle walls has been found to be of advantage, since the same therapeutic result can be obtained without as great an inflammatory reaction and after-discomfort to the patient as when all the beta rays are employed. Also, there is less danger of subsequent formation of undesirable sloughs.

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., MAY 22–23, 1922.

By the use of radium in needles, and the judicious consideration of this property of filtration, a dose can be given which will exert a lethal action upon malignant cells without causing necrosis with sloughing, but rather, a retrogression of the growth and relative conservation of the normal cellular elements. The general appearance is that of mummification, rather than the usual necrotic changes.

A small quantity of radium, from 1 mgm. to 10 mgm. in each needle, can be used to even greater advantage than a larger quantity, for the reason that this greater concentration will be more likely to produce sloughing, while the desired effect is to change the character of the cells and render them innocuous by atrophy, also secure final replacement by fibrous connective tissue.

Small quantities of radium in needles inserted at equidistant points throughout a growth, will, by cross-fire action, result in homogeneous radiation over a wide area, while a single capsule or needle containing a large quantity of radium, whether buried in the growth or applied to the surface, will exert its greatest influence at the point of contact, its effect growing rapidly less potent as the distance from the radium is increased.

Dosage is all-important in radium-needle application and is most difficult to estimate. Important points to be considered are: the anatomical location of the neoplasm, its type and its grade of malignancy. For example: the uterus will stand a larger radium dosage than the rectum; the breast, than the buccal surface, the tongue, the floor of the mouth or the tonsils; the stomach, more than the intestines, etc. The requirements of the individual case must, also, be studied. A correct technique is, therefore, of the utmost importance. With good judgment and such technique, most gratifying results will often be obtained; but should mistakes be made in any of these several factors, much damage and suffering may result. For example, too small a dose may only stimulate the neoplasm, while an overdose may result in such dense fibrosis that circulation in the mass is totally arrested. Then, within a few weeks or months, sloughing will occur, resulting in an ulcer, which will not heal. This condition is as bad, though benign, as was originally present.

Radium needles should be used very guardedly near bone, since experience has taught that the vitality of normal bone is easily impaired. As a result of such damage a sequestrum will often form, necessitating surgical removal; or, a fibrous periostitis has been known to occur, and the resulting pain has been so great and persistent that opiates were called for in increasing quantities.

Radium needles attached to strong braided silk thread may, after careful sterilization, be inserted into some of the abdominal viscera immediately following a laparotomy.

It has been my clinical experience that needles containing 10 mgm. of radium should not be inserted into a malignant growth at a distance greater than 25 mm. apart, as a lethal effect, from this standpoint, will not be produced beyond this distance. In some instances the distance should be even less, depending upon the degree of radiation concentration desired, the exact amount of radium in each needle, and also, the time allotted for the treatment.

Needles with cutting trochar points have been found to be more generally useful than those with round tapering points. A trochar is used before the insertion of a needle if the tissue is dense, but if of soft consistency, the needle may be inserted directly into the tissue.

Where concentrated action of radium is desired, radium needles may be grouped together and used in a metallic container, with proper filtration. Or they may be placed side by side in a flat metallic container for surface work.

An efficient radium needle equipment consists of very small irido-platinum needles containing as little as 1 mgm. of radium, platinum, irido-platinum or steel alloy needles, containing 5 and 8 mgm. respectively, and steel alloy needles containing 10 mgm. Some of these needles should be of the "combination" type, so that either a thread or a screw-shank may be attached for superficial or deep work, respectively. Needles may, of course, contain larger quantities of radium than 10 mgm., but I have found this a convenient unit with which to work and to meet all requirements.

The very small platinum needle containing 1 mgm. of radium is indicated in the same conditions as is the glass radium emanation "seed," and has the advantage that it may be withdrawn after sufficient radium dosage has been given; whereas, the glass "seed" remains in the tissue, where, though it later becomes incapsulated, it may still be considered a foreign body.

Capillary tubes containing radium emanation may be inserted into needles and used with satisfaction. Many radiologists, however, who have a choice of needles containing the element or emanation, prefer the former, owing to the greater stability of the radiation given off by the element.

When a malignant or other growth has received a maximum radiation dose with needles, it is inadvisable to employ them again, should the same tissue need further treatment, as there is a tendency for such tissue to break down under these conditions. Radiation treatment, either with radium or the *x*-rays, may, however, be carefully given from the surface, at subsequent periods, without great danger of such a sequence.

The secondary radiation from metal in contact with the tissues beneath the surface does not produce such an acute reaction as does contact of the metal upon the skin surface.

The patient should be prepared as for any surgical operation, since infection may occur if the field is not sterile. The needles may be inserted, as a rule, under local anesthesia. Where, however, many needles are to be employed, or there is any other contraindication to the use of local anesthesia, such as a supersensitive or nervous patient, general anesthesia may be induced.

I do not use radium needles in localized basal-cell epitheliomata, or even in localized malignant lesions of any type, unless it be as a secondary measure, the electrodesiccation and electrocoagulation methods being much to be preferred, provided the condition is such that the disease can all be destroyed at once. When, however, the disease is not amenable to immediate eradication by electrothermic methods or surgery, or when metastasis has occurred, then radium needles alone, or in combination with other measures, may be depended upon to yield satisfactory results, in many cases.

Among the anatomical locations and conditions, malignant and otherwise, in which radium needles may be used, are: Adherent neoplasms of the cornea and bulbar conjunctiva; growths between the globe and floor of the orbit not involving the lid, in which needles could be inserted through the lid into the growth; deep seated growths of the canthi; laryngeal growths in which small needles could be inserted between the membrane and the cartilage; growths of the tonsils, pharynx, soft palate, buccal surface, tongue, and floor of the mouth, anterior and posterior nares, and the esophagus; metastatic cervical and other glands; inoperable cancer of the breast; cancer of the pyloris and other parts of the stomach (after laparotomy and gastroenterostomy); cancer in some other of the abdominal viscera, and of the bladder through a suprapubic opening, or per urethra; cancer of the uterus involving outlying regions impossible of access by capsule, but which, if impossible to reach entirely from below, can be reached from above through an abdominal incision; neoplasms of the urethra and rectum; cancer or hypertrophy of the prostate by suprapubic, perineal or rectal route; large cavernous angiomata; exopthalmic goiter.

There is much more to be said relative to the value and technique of radium needle application, but to discuss the subject further would be to exceed the scope of a single paper.

In conclusion, it may be asserted with assurance that radium needles fulfill an entirely unique place in our equipment and have aided very materially in the fight against neoplastic diseases.

DISCUSSION

Dr. Kirkendall. Over a year ago I commenced to boil radium needles. Since then I have had two interesting experiences: in one instance, the needle broke directly through its center, making a hinge joint, with the raw radium visible, and in the other, the eye pulled out. Both needles were sent back to the factory for replacement. There was no loss of radium in either needle. Dr. Clark did not mention how he sterilizes his needles, but I have found it satisfactory to boil them.

In treating a malignant growth directly under the skin, if you wish to needle the growth, the needles will stay in better if the eye of the needle is pushed clear below the skin level.

I believe that the superficial malignancies of the skin are best treated with a surface pack of radium.

When a malignant growth is deep-seated and in an area of the body where the growth is near the superficial lymphatics, or where the part is drained by many lymphatics, as in a case of cancer of the breast, I think the growth proper should be needled first (buried radium needles) and all the surrounding areas treated afterwards with a surface radium pack, in order to catch any malignant cells that may have been squeezed out by the application of the needles and other manipulations. If this procedure is reversed, and the outside areas are treated before the growth proper is treated, the trauma to the growth may recontaminate the outside areas, and by so doing, render the treatment useless.

I would like to report a case of buried radium needles in a woman forty-eight years old who had had two previous operations for recurrent cancer of the breast. The radical operation for removal of the breast occurred in July, 1915, with a microscopic diagnosis of adenocarcinoma. In 1920, a recurrence in the axilla was incompletely excised. The recurrence surrounded the axillary vein. Again a section was taken, with the same diagnosis. A surface radium pack was used. In July, 1921, she came back with a mass in the axilla about the size of a hickory nut. The mass was exposed and found to surround the axillary vein. It could not be removed, and five 10-mgm. needles were inserted into the mass and left *in situ* for seven hours. There was no serious reaction, the growth ceased to increase, and then shrank to the size of a bean. The pain in the arm and shoulder that she had been having gradually ceased, as did likewise the swelling in the arm. I report this case to show that we do not need to be much afraid to insert radium needles near the large blood-vessels.

Dr. Pancoast. There is, I think, a certain amount of danger from the traumatism caused by the implantation of needles in some growths as a cause of metastasis. Wherever possible, I think the preliminary surface radiation should be carried out first.

I believe in boiling needles in the sterilization process, and use the Bowen holder in doing it. One should be careful that the water does not boil away. We have had one unfortunate experience with infection following needle implantation. A man with a cavernous angioma of the soft palate had two needles implanted in the growth and within a few hours he had a very sore throat, and five days later died of pyemia. A blood culture showed hemolytic streptococcus. He, of course, had the infection in his throat at the time the needles were put in, and the infection was carried in by the needles.

Dr. Bowing. I have had the same difficulty—bending or breaking of needles, as well as dislodging the eye. It has been my policy (because the metal in the needle will not retain a sharp point, and constant sharpening wears the needle back into the radium cavity) to cut the way with a small, sharp-pointed knife, just enough to get the needle in, as well as to the proper depth. I place the knife just where I want to place the needle, then withdraw it sufficiently and enter the passageway with the needle holder to deposit the needle. In this way I do not break the needle or traumatize the tissue.

I would not consider a thread as a means of withdrawing the needle. It cannot be safely sterilized. I am using a fine resistance wire which is sufficiently strong and can be properly sterilized.

The only thing I have to contend with is hemorrhage, and a little packing usually suffices, and is held in place with adhesive strips.

Dr. Aikins. I have a great many difficulties with the needle and have been using flat applicators for thirteen years. I get much better results than with needles in surface work, and I am sure if the gentlemen will try them out they will be pleased.

Dr. Clark (closing discussion). Radium needles should be sterilized thoroughly. Failure of such precaution may result in serious local infection or even septicemia. There appears to be a wide-spread belief that boiling destroys the efficiency of the needles, but such is not the case. They may be boiled as frequently as is necessary. The next best method of sterilizing radium needles, threads and wire, is to place them in a formalin bath followed by absolute alcohol, and finally, by sterile water.

Radium needles may be inserted into soft tissue without the previous use of the trochar, but in dense tissue, the trochar, or the narrow scalpel suggested by Dr. Bowing, may be employed previous to the insertion of the needles.

As needle sutures, my preference is for heavy braided silk thread, as it is much easier to handle than the wire. Moreover, wire is easily kinked and may break when least expected.

SUPPURATIVE OSTEOMYELITIS OF THE LEFT SIDE OF THE PELVIS

BY IRWIN P. LEVI, M.D.

Roentgenologist, St. Luke's Hospital

ANNISTON, ALABAMA

The following case is reported because of its apparent rarity and because practically all the more common textbooks on the subject of surgery fail to contain any mention of its occurrence, or the important part the roentgen ray plays in the diagnosis of this disease. Even so complete a treatise as "Keen's Surgery" contains no mention of this condition. Nor have I been able to find any mention made of it in any roentgenological journal of recent date. The only textbook in which I could find a description of this condition is the treatise on surgical diagnosis by Dr. A. B. Johnson,[1] in which work there is a page devoted to this subject, with a description of the etiology and symptoms thereof.

Etiology. Johnson states that this condition is a rare one; that the ilium is more frequently attacked than any other of the pelvic bones, and that in the lines of union of the several bones the acetabulum is the favorite seat of localization. Save for direct infection through wounds, where the infection is carried to the site of the disease, the occurrence of the infection is more frequent in childhood. While in a certain percentage of cases subcutaneous injury, often of only slight severity, may be the direct causative factor, it is difficult to say in many cases whether the injury itself had any relationship to the inflammation of the bone.

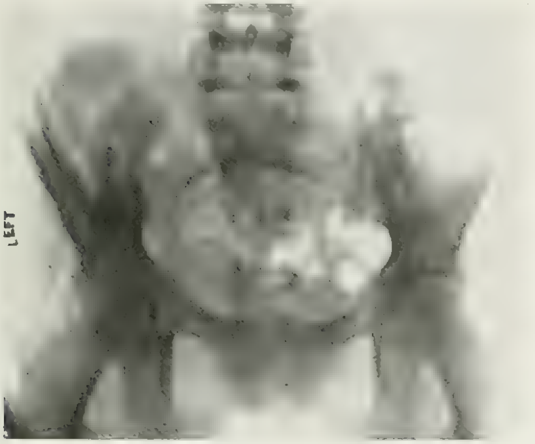
Symptomatology. Johnson gives the symptoms as similar to those of osteomyelitis elsewhere in the body, together with some special localizing symptoms. The symptoms of osteomyelitis are in general those of sepsis; fever of moderate degree, with morning or evening exacerbations or both, an increase of leucocytes, with relative increase of polymorphonuclear cells, and the general picture of an intense poisoning of the body by infection. With this picture one may find localized tenderness, pain and swelling of the involved parts, and, after a week or two, if the patient survive that length of time, the signs and symptoms of a deep-seated suppuration will become evident. If the acetabulum is involved, the picture may resemble an acute inflammation of the hip joint. In general, these are the symptoms given of this condition, and, to quote Johnson again, "The picture is often one of an intense and rapidly fatal sepsis, in the face of which surgery finds itself quite helpless."

Female, aged fifteen, white, height 5 ft. 6 in., weight approximately 85 lbs.

Past History. Patient has had mumps, measles and whooping-cough. No scarlet fever, or any other serious illness. No history of pulmonary disease, save an acute attack of influenza two years ago, moderate in severity and lasting ten days.

Family History. Mother living and well. No history of miscarriages. Father died of pneumonia. Two sisters and one brother living and well. Hygienic conditions of residence normal.

Present Illness. On June 25, 1921, patient began to complain of pain in left buttock and inability to use the leg to any great extent. This condition rapidly grew worse; on June 27th the patient was not able to use the limb at all. She was then put to bed; temperature 105° F. Shortly afterward she became delirious, but during the entire delirium did not attempt to use either lower extremity or to move herself about in bed, but tossed her head from side to side and attempted to rise on her right elbow.



Osteitis of left side of pelvis.

The blood was examined for malaria and for typhoid fever—both tests negative. The tentative diagnoses were ptomaine poisoning and peritonitis, probably due to a ruptured appendix. The abdomen was markedly distended and rigid, and very painful to palpation. During this time she expectorated a moderate amount of blood.

At the end of ten days the temperature fell to 100°F. in the morning with evening rises to 103°, and the delirium subsided. The abdomen became less tender and the distention lessened. About this time, there was swelling over the external condyle of the right elbow, which was tender and red and the presence of fluid was suspected. Under local anesthesia an incision was made and pus obtained. The wound healed rapidly. During the next fortnight it was noticed that the left thigh became larger than the right. The thigh was opened under local anesthesia, the opening being about 3 to 4 inches below the greater trochanter of the femur. Foul yellow pus was found. Immediately the temperature dropped to normal.

Roentgen-ray Examination (September 1, 1921). Evidence of a former periostitis in the region of the right elbow-joint, limited to the humerus. Periosteal increase over the internal and especially over the external supracondylar portion of the humerus. The structure of the bone appears normal; no evidence of active infection demonstrable. No involvement of the upper portions of the radius and ulna. The films of the pelvis show evidence of a marked suppurative process involving practically the entire left side. The left side of the sacrum at, and in close proximity to, the sacroiliac synchondrosis is involved, with entire loss of detail of line of articulation. The entire iliac bone is involved as far downward as the iliopectineal line, with two irregularly oblong areas of decreased shadow density, each measuring approximately 4 cm. in length and 2 cm. in width. The acetabular cavity, as well as the head of the femur, is not involved in this process. There is some degree of bone proliferation at the lower margin of the left sacroiliac articular line, as well as on the external surface of the iliac bone just above the acetabulum. Some roughness of outline and evidence of periosteal proliferation of the ramus of the ischium, together with a slight increase in the size of the bone. The pubic bone appears to be normal in outline. Films of the lumbar spine, made to eliminate the possibility of a psoas abscess as the underlying cause, show it to be normal with no evidence of bone infection. The infectious process seems to be limited purely to the left sacrum, iliac bone, and the ramus of the left ischium.

This case presents the following points of interest:

1. Its rarity.
2. The occurrence of the symptoms of peritoneal involvement, due probably to the leakage of the products of infection through the thin peritoneal lining of the abdominal cavity and giving rise to the symptoms of a general peritonitis. This demonstrates clearly that in a case presenting the symptoms suggestive of a general peritonitis, without localizing symptoms and without the history of a disease that would of itself indicate the lesion, such as typhoid fever, pelvic infection, etc., occurring in a child, the possibility of a pelvic osteomyelitis should not be disregarded and a roentgenological examination should be made of the entire pelvis to determine the possibility of infection. The symptoms of general peritonitis were the predominant ones in the early stage of the disease.
3. The occurrence of so extensive a process without any history of injury even of a trivial character, or without any other localizing symptoms save a disinclination to use the left leg, and yet at the same time possessing no symptoms which would localize the process to the left hip-joint, or to the limb of the side of the pelvis involved.
4. The necessity of routine roentgen-ray examination in all cases presenting symptoms suggestive of pyemia, or of hidden infection, and yet possessing no localizing symptoms, or faint ones at best. By this means and with this aid, many infections whose origin is an apparent mystery, can be definitely localized and adequately and properly treated to prevent possible death, or at least limit subsequent deformity.[1]

---

[1] Johnson, A. B. Surgical Diagnosis, iii, 128.

GLASS RETAINED IN THE HAND AND FOOT

BY ARTHUR S. RISSER, M.D.

Surgeon, Blackwell Hospital

BLACKWELL, OKLAHOMA

Numerous instances are recorded in which bullets and other foreign bodies have been retained in the human body for varying periods of time without apparently causing any troublesome symptoms. Such objects, as a rule, are compact and relatively small in size and have comparatively rounded outlines and smooth edges. It would seem impossible that extremely sharp-edged and pointed objects, such as splinters of glass, could be silently retained in the active, delicately constructed portions of the body, such as the hands and feet. Their complex anatomy of tendons and tendon sheaths would seem to preclude retention without immediate and greatly impaired function. Such instances as those reported in this paper would seem to be comparatively rare and illustrate what might be called the accommodative powers of the human body.

It would be of interest to know how frequently retained fragments of glass occur in the practice of individual physicians; and also how often they are detected by means of the roentgen ray. The following cases may be of sufficient interest to warrant reporting.

Case I. (x 273). Came to the Blackwell Hospital May 17, 1918, complaining of increasing pain and disability of the left foot on attempted walking. Only a small scar was visible on the plantar surface of the foot, and no tumor or swelling was present. His personal history developed the fact that nineteen years before, when a small boy, he had stepped barefoot into a box of glass. Immediately after the injury the physician in attendance had removed several spicules of glass from the wound, after which it healed rapidly. Though he led a very active life on the farm and in the oil field, the foot had never troubled him until a few months previously. A roentgenogram showed a foreign body deep in the plantar fascia which was diagnosed as a piece of glass. On May 21, 1918, under local anesthesia, an irregular piece of glass measuring $1\frac{1}{4}$ in. by $\frac{5}{8}$ in. was removed from beneath the deep plantar fascia.

---

[1] Johnson, A. B. Surgical Diagnosis, iii, p. 128.

Case II. (x 476). On April 16, 1918, while engaged in a friendly scuffle, the patient ran his right hand into a glass door, smashing the glass and making a small lacerated wound on the dorsum of the hand. In dressing the wound no glass was found, and the patient insisted that no roentgenogram was necessary, since he was sure it was only a superficial wound and would "soon heal." This it did promptly and without infection or pain. The patient is a chemist for a large industrial organization, using his hands actively: and not until some twenty months later did pain and impaired function develop. On January 30, 1920, he consented to a roentgen-ray examination, which disclosed a large triangular fragment of glass between the third and fourth metacarpal bones and at right angles to their axis. Even at this time, the pain and incapacity were comparatively slight, so that it was not until almost a month later that he finally submitted to operation. However, on February 24, 1920, under local anesthesia and a dorsal incision, the glass fragment was found and removed. Recovery was uneventful.

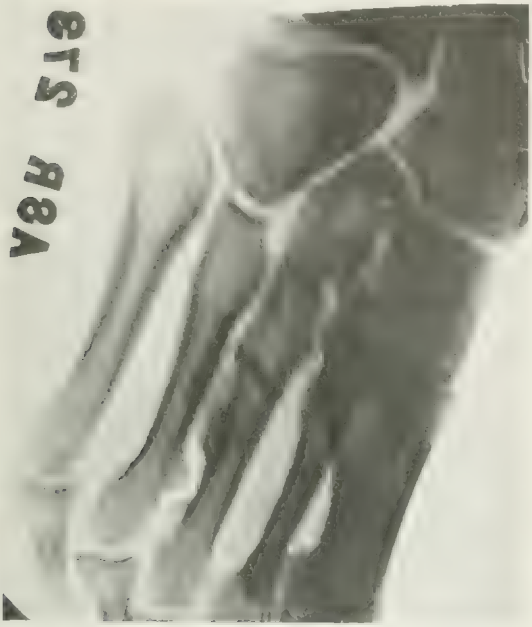


Fig. 1. Case I. Left foot, dorsal view. Glass in foot for nineteen years.

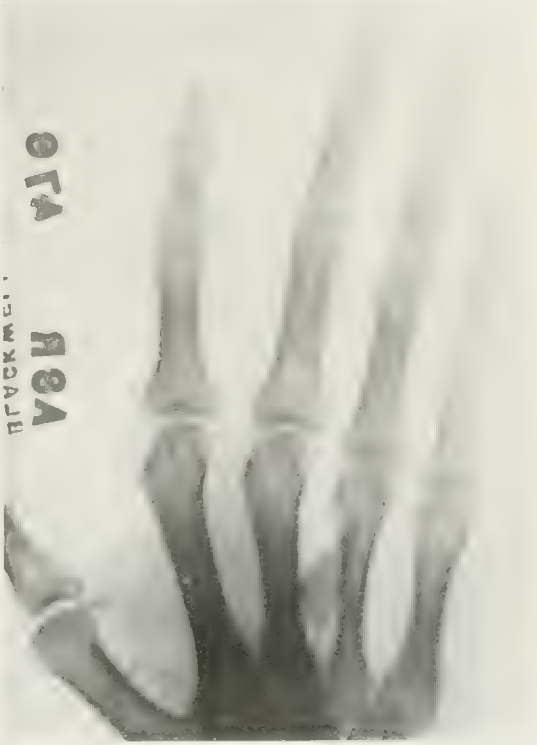


Fig. 2. Case II. Right hand, dorsal view. Glass in hand for twenty-two months.

STATISTICS AND TECHNIQUE IN THE TREATMENT OF MALIGNANT DISEASE OF THE SKIN BY RADIATION*

BY HOWARD MORROW, M.D., AND LAURENCE TAUSSIG, M.D.

SAN FRANCISCO, CALIFORNIA

THE treatment of malignant diseases of the skin was one of the first fields of usefulness noted for radium, and it has remained one of the most important as well as one of the most satisfactory. It is not within the scope of this paper to go into the voluminous and growing literature on the subject. The malignancies of the skin that we are called upon to treat are the basal-celled epitheliomata, squamous-celled epitheliomata and the various types of cutaneous sarcomata. The technique of treating these lesions with radium will be discussed, and then the statistics will be presented.

Rodent ulcer or basal-celled epithelioma is one of the most satisfactory types of malignancy to treat because of its slow course and because it does not involve the regional lymph-nodes. Its common occurrence on the face, especially about the canthi and eyelids, makes it important to produce the best possible cosmetic result. Radiotherapy has become the treatment of choice for these lesions because of the ease with which it is applied, even in difficult positions, the good cosmetic result with the production of a soft, supple, relatively small scar, and because it is painless. The technique of treating the average case is simple. A radium plaque, preferably of full strength, large enough to cover the lesion with a margin of 1 to 3 mm. may be used, screened with 0.1 mm. of aluminum and a single layer of rubber dam, for a total of two to four hours, divided between two or three days. If the lesion is very superficial, the time may be cut down to one or two hours. If the lesion is rather deep, the screening may be increased to 0.5 mm. of aluminum and the time increased to five or six hours; or one hour may be given with the lighter screen and four or five hours with the heavier screen. If tubes are used, 40 to 60 mc. hours should be given to each sq. cm. of surface of the lesion, screened with 0.5 mm. of silver and 0.5 to 1.0 mm. of rubber or its equivalent. Lesions at the nasolabial fold and behind the ear lend themselves particularly well to treatment with tubes. In treating growths about the eye, it is not necessary, as a rule, to protect the conjunctiva, as it is very resistant to radiation, the reactions which are set up clearing rapidly without causing permanent damage. Every now and then a deep nodular basal-celled epithelioma is encountered which is resistant to surface applications. For these, the best form of therapy is the insertion of unscreened tubes of emanation, if they are available. These tubes may be of 0.5 mc. each or less, the number depending upon the size of the nodule treated. One or two such tubes are usually sufficient. If emanation cannot be obtained, steel needles containing radium element may be inserted into the growth,

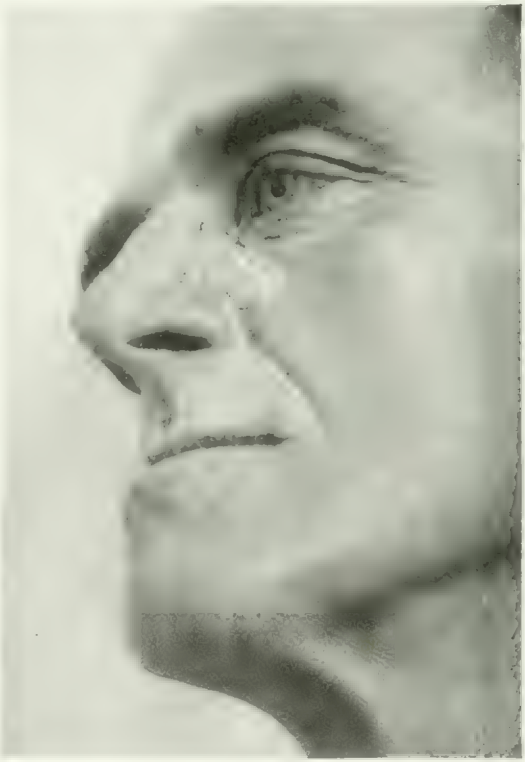


FIG. 1. Basal-celled epithelioma, cicatrizing type. Treated with radium plaques.

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

the time of exposure depending upon the amount of element in the needles and the size of the growth. Fortunately, we are not seeing many of the very extensive long-standing cases with great destruction of tissue, which were so common a few years ago. It is always possible to keep this type of basal-celled epithelioma under control, but it is almost impossible to produce a permanent cure in many of them. The borders of such very extensive growths should receive the most attention, as the activity is usually confined to this area. Whenever bone is involved, the prognosis must be guarded. If the bone involvement is not too extensive, a thorough raying, with the production of a severe reaction, may cause a sequestrum to form, which, when it separates, will carry with it all the remaining malignant tissue. The question of curetting the pulpy rodent tissue before radiation is still an open one. The advantages are: Lessening the time of radiation by about one-half, the exposure of the true extent of the lesion, which cannot always be accurately judged by observation and palpation, and the procuring of tissue for a microscopical examination. It is also likely that the percentage of recurrences will be less if the lesions are curetted before radiation. The chief disadvantage is that it probably increases the scarring somewhat, and this is of particular importance in lesions about the eye. In addition, curetting is apt to be rather painful. The question can only be solved by experience. It will probably develop that certain well-defined types should be curetted before radiation, while others should receive radiation only. At the present time, it is our custom to curette and immediately radiate all basal-celled epitheliomata when the nodules are large, and we believe that in all ulcerated types, radiation without curettage is all that is necessary. We are convinced that in the majority of these cases of rodent ulcers, radiation with the *x*-ray in experienced hands is capable of producing just as satisfactory results as radium, though our own experience has been limited to the latter. It is certain, however, that radiation with the *x*-ray is impracticable with lesions located in the natural fissures and about the eye.

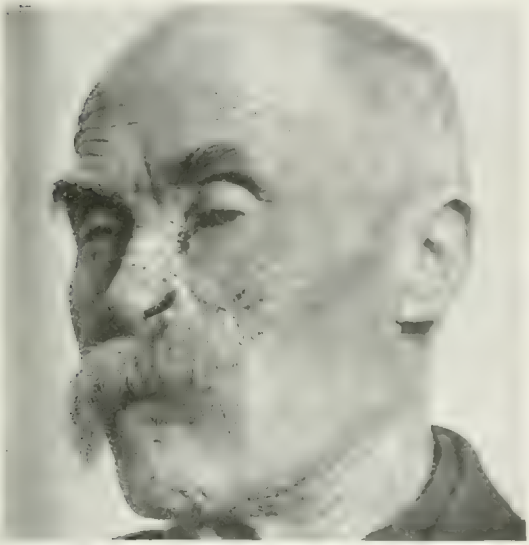


Fig. 2. Basal-celled epithelioma, cicatrizing and ulcerating type. Treated with surface applications of radium in plaques and tubes.

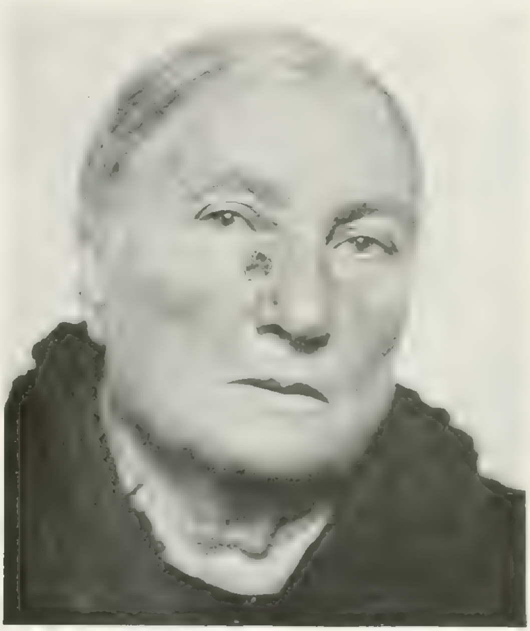


Fig. 3. Basal-celled epithelioma. Curetted on account of the depth of involvement and treated with radium plaques.

The treatment of cornifying epitheliomata presents a much more difficult problem. Fortunately, these growths occur far less frequently than rodent ulcers. They are rapid growing, usually metastasize early, and may be resistant to radiotherapy. In general, two clinical types of squamous-celled epitheliomata are encountered; those in which the predominating direction of growth is exuberant, and those in which the growth is indurating. The exuberant, everting type is usually less malignant, metastasizing later and responding better to radium therapy, partly because it is more accessible. The two types merge into one another and the everting growth always eventually indurates. In all of these, radiation should be thorough, and little thought may be given to the cosmetic result. Surface radiation should be carried out as for basal-celled epitheliomata, or somewhat more intensively; and in addition, unscreened tubes of emanation should be seeded throughout the mass, using approximately one tube of 0.5 to 1.0 mc. per c.c. of tumor. When in doubt, use too much rather than too little. If emanation is not to be had, steel needles containing radium element may be effectively used. Only the most superficial and small squamous-celled epitheliomata may be treated by surface radiation alone. In addition to thorough radiation of the primary lesion, attention must be paid to the neighboring lymph-nodes. If these are not already palpably involved, they should be thoroughly rayed with the *x*-ray. If they are involved, they should first be rayed, and then removed surgically with the associated gland chain, if that is possible. If this is not possible, they should receive surface radiation, and then be seeded with bare tubes of emanation, or steel needles containing radium may be inserted. This procedure may make them operable later. In some cases, partial operation with the insertion of emanation tubes at the time of operation may be indicated. It is probable that the perfection of the technique of deep *x*-ray radiation will improve the prognosis of these cases, even to the point of making operation unnecessary. We have practically abandoned the use of the radium pack in favor of the *x*-ray in the treatment of the lymph-gland areas, because it is apparently just as efficacious and more economical.

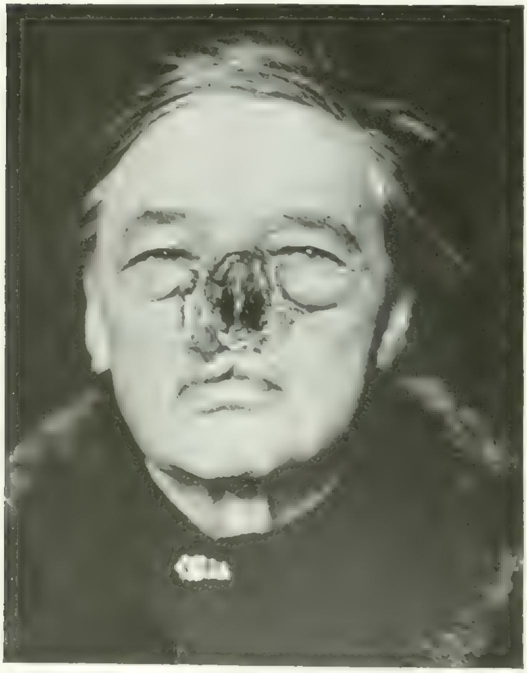


Fig. 4. Basal-celled epithelioma. This is the type that can usually be held in check but can rarely be cured.

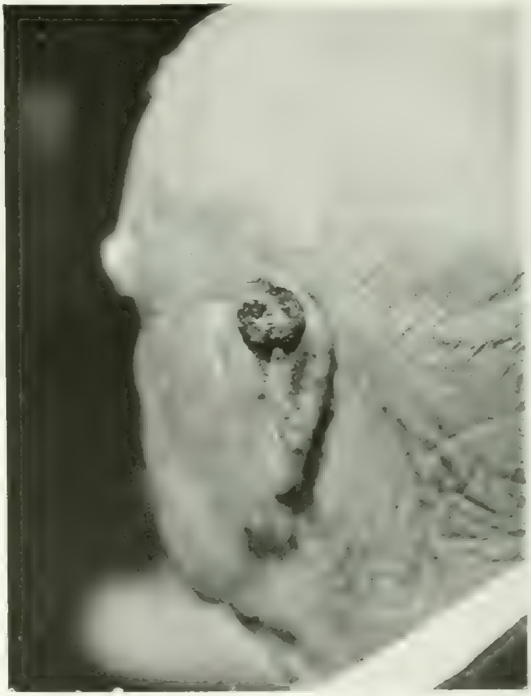


Fig. 5. Squamous-celled epithelioma of the ear. Treated by the insertion of bare tubes of emanation and surface applications of radium.

Epitheliomata of the ear present a special problem. They are often of the squamous-celled type, but are usually less malignant than this type of growth elsewhere on the glabrous skin. Nevertheless they are often resistant to radiotherapy, and adequate doses to lesions in which the cartilage is involved produce painful and slow-healing reactions. The smaller lesions may properly be treated with radium alone, but those of more than 1 cm. diameter should be thoroughly curetted, cauterized, preferably with pure chromic acid or the actual cautery, and then rayed cautiously. In epithelioma of the ear, the local lymph-nodes need not be rayed unless the lesion is very extensive, but they should be carefully watched. Of course, palpable involvement should be looked for, and if present, should be treated as indicated above. *X*-ray therapy of squamous-celled epithelioma of the skin has not been very satisfactory as yet.

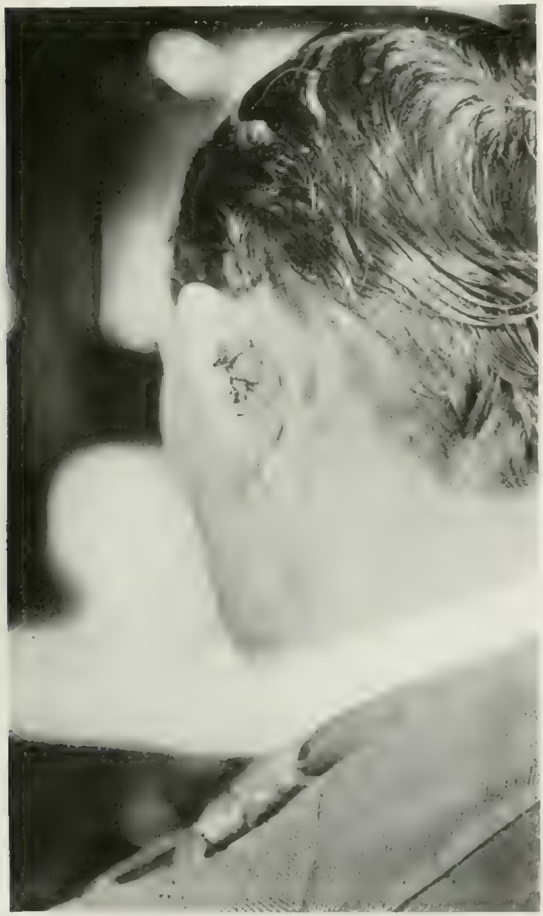


FIG. 6. Squamous-celled epithelioma of the ear simulating a basal-celled epithelioma. Curetted and treated with radium plaques.

Sarcoma cutis is much less common than either of the types of epithelioma of the skin. These sarcomata vary greatly in their susceptibility to radiotherapy and in their grade of malignancy. They are inclined to be very malignant, and should be treated in accordance with the principles laid down for the treatment of squamous-celled epitheliomata. The local lesion of myxofibrosarcoma responds rapidly to radium, but distant metastases occur sooner or later. Very small fibrosarcomata may be curetted and then radiated intensively with good results. The so-called melanosarcoma is exceedingly resistant to radiotherapy. The more pigment present, the more resistant the lesion is. Usually the individual lesions do not respond at all to therapy, and even if they do, distant metastases are the rule. Many of the reported cures of melanosarcoma

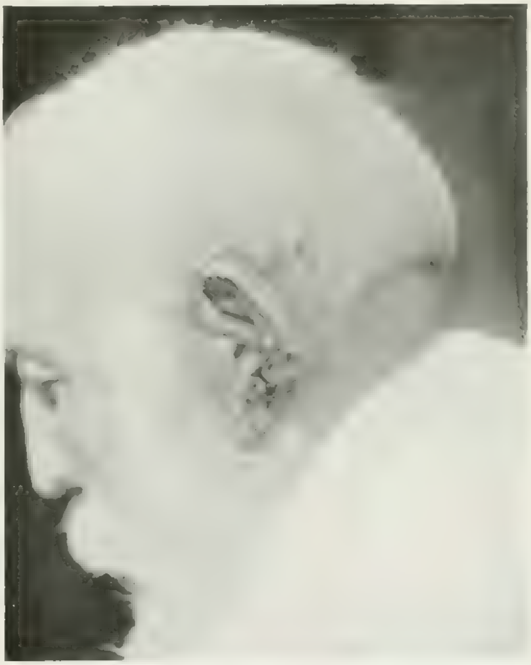


FIG. 7. Squamous-celled epithelioma of the ear. Resisted radium therapy alone and was curetted and cauterized with chromic acid crystals, following which radium was applied.

are probably errors in diagnosis, and the lesions which were treated were fibrous nevi with increasing pigmentation.

In Table I, we have divided the cases of basal-celled epithelioma into three classes. The first, which is by far the most common, is the small superficial type of lesion. This occurs, for the most part, in cases which could be cured readily by a number of other methods, but in which radiotherapy is chosen as producing the best cosmetic result. The second division includes the more extensive lesions which have not, however, involved the deeper structures. The third class includes those in which cartilage or bone was involved, or those in which the growth extended down into the orbit. A fairly large number of lesions were curetted before being radiated. Those classified as clinically cured were not, in all cases, cleared by a single course of radiation. Quite a number of them recurred after insufficient treatment and were retreated. They reacted as satisfactorily to radiation as before in every case. Those classified as still under treatment have been stubborn, and have been treated repeatedly, but they are lesions that we still expect to cure, often with the aid of curettage. Those recently treated have not been included in this table. The failures are patients who have passed out of our hands, or have died while still showing evidence of the disease.

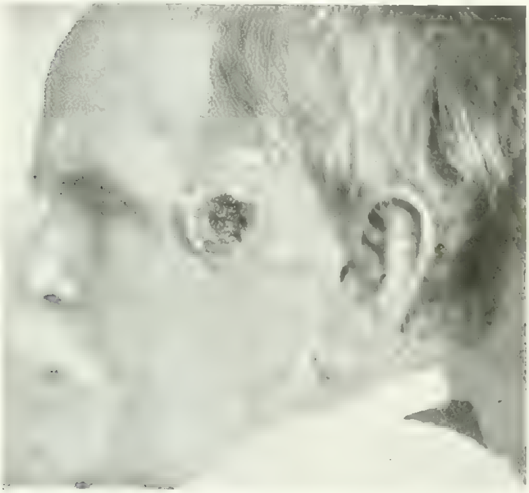


Fig. 8. Squamous-celled epithelioma of the face. Treated by insertion of bare tubes plus intensive surface applications.

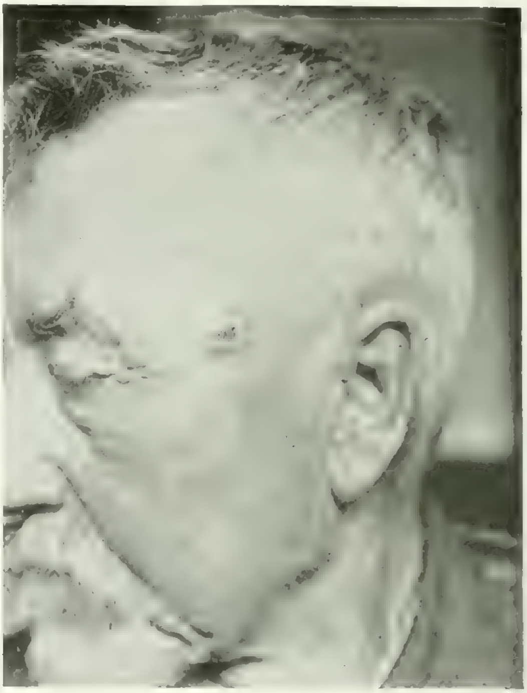


Fig. 9. Squamous-celled epithelioma of the face. Intensive surface applications of radium were used in this case.

Table II shows the number of squamous-celled epitheliomata which we have treated during the past three years, indicating the number of cases which have responded well primarily, and those which were failures. The time is too short to consider any of them as cured. The lesions have been divided into those of the ear and those of other portions of the glabrous skin. Lip cancers have been purposely omitted as not coming within the scope of this paper. The lesions classified as still under treatment are lesions which have cleared satisfactorily, but which have not as yet been clear for six months.

Table III indicates the number of sarcomata of the skin that we have attempted to cope with. We have declined to treat a number of melanosarcomas, having found the lack of efficacy of radiotherapy in these cases. The two small fibrosarcomata which we have apparently cleared, were each less than 1 cm. in diameter, and both of them were curetted before applying radium. The larger lesions cleared apparently for a time and then got out of hand.

Our experience has convinced us that radium therapy, combined in appropriate cases with other methods, is the most satisfactory for cutaneous malignancies.

TABLE I

BASAL-CELLED EPITHELIOMATA

	Number of cases	Clinical cures, under one year	Clinical cures, over one year	Still under treatment	Failures
Small and superficial	262	97	165	0	0
Extensive and superficial	28	7	15	4	2
Deep	32	9	6	9	8
Total	322	113	186	13	10

TABLE II

SQUAMOUS-CELLED EPITHELIOMATA

	Number of cases	Clinically clear, over six months	Still under treatment	Failures
Lesions of the ear	28	15	4	9
Lesions in other locations on the skin	11	5	1	5
Total	39	20	5	14

TABLE III

CUTANEOUS SARCOMATA

	Number of cases	Clinically clear, over six months	Failures
Melanosarcomata	4	0	4
Fibrosarcomata, small	2	2	0
Fibrosarcomata, large	4	0	4
Total	10	2	8

DISCUSSION*

DR. STEVENS. If any one thing is established, I think it is the radiation treatment of superficial malignancies. No doubt we get as good results, and I think better results, by this than by any other method, such as operation. Of course, it depends upon the type of growth as to how it should be treated. Basal-cell carcinoma of the skin will probably respond to almost any treatment. Operations probably give 80 to 90 per cent of cures, and radium will do the same. I think there is very little difference between radium and *x*-ray. In squamous-cell carcinoma the chances of success are much less, and in those I feel that we need the combination of radium and *x*-ray, because of the danger of metastasis. The neighboring glands, certainly in every case of squamous-cell carcinoma, should be rayed.

I noted in Dr. Quigley's paper, in speaking of cancer of the lip, he said nothing of radiation of the glands of the neck. I would like to know whether he carries this plan out, or whether he simply treats the local growth. It has been our custom, in these cases, to give the glands of the neck a deep *x*-ray radiation along with the radium radiation of the primary growth.

In melano-epithelioma the results are not so satisfactory, although Dr. Quigley reports several very good results. In reporting the case involving the eye alongside of the iris, he reminded me of a case I had some ten years ago. The case had been operated upon and a microscopic examination made, and the growth returned. It was reported melanosarcoma. The patient was referred to me by the surgeon who operated, I treated the growth with *x*-ray, and it cleared up. I have not heard from the patient for seven or eight years.

In cancer of the penis, I have treated 3 cases, in one of which there was involvement of the glands in the groin and suprapubic region. This was a very extensive case of squamous-cell carcinoma. I radiated the glands in the groin and suprapubic region with deep *x*-ray therapy, as deep as we knew how to give at that time (this was seven years ago) using 4 mm. of glass and a piece of sole leather, and cross-firing from several ports. Then I gave a very heavy dose of *x*-ray to the penis, immediately after which I sent the case to the surgeon. The penis was amputated and I gave postoperative radiation for two months. The patient is well today. The other cases had similar radiation treatment followed by operation and are well after two and four years.

When cancer of the face involves the periosteum, I have not been very successful with *x*-ray or radium alone, but have found that by combining electrocoagulation with radium I get very good results.

A sequestrum will have to be surgically dealt with later in these cases, but the final results are often very satisfactory.

DR. PANCOAST. One point in Dr. Quigley's paper which I wish to discuss is the treatment of epitheliomas involving the orbit. He said that as a rule they do not get well when the orbit is beginning to be involved. I think in such cases it is a question of sacrificing the eye or the patient. We find in these cases that when the eye itself is involved, and there is no chance to save it, the sooner it is removed the better, for then one has an opportunity to reach the point of extension into the orbit.

---

* This discussion has reference to the paper by Dr. Quigley, which appeared in February, as well as to the above.

Dr. T. C. Kennedy. No case of cancer of the lip should be operated upon until radium has been thoroughly tried. If radium is used in cancer of the lip, by a thorough technician, there will be but few cases to go to the surgeon.

Pre-operative radiation has been advised, but if this is given, more than 60 per cent will be cured, and very few of the balance will be found fit subjects for operation.

In all cases, the glands should be thoroughly radiated. The cosmetic results from radium are far superior to those from surgery, which is an important consideration.

Dr. Lain. I do not wish to give a part of the paper which I am to present later to the section of dermatology of the A.M.A., but I wish to discuss this important phase of superficial epitheliomas of the lip. I fully appreciate what the authors have said about the apparent ease of curing superficial epitheliomas in certain places, but for fear some one inexperienced in this line of work may get the impression that they are all easy, I think we should stress the point that it is necessary to forestall metastasis by deep *x*-ray or a radium pack to the common metastatic regions. In my paper I have reported 97½ per cent cures in group No. 1. Two of the failures were due to our early inexperience, or lack of treatment of the submental and submaxillary glands. I do not think it is fair to classify all cases of epithelioma into a general group and declare a certain percentage of cures and a certain percentage of failures. The superficial type of epitheliomata of the lip, those not already involving the mucous membrane, will nearly all get well without raying the submental or submaxillary glands; but this is not true of any of those that involve the mucous membranes, are deeply infiltrated, or are adjacent to an abundant lymph drainage. You must forestall this class of cases by treating thoroughly the regions mentioned, and when you do, you will materially raise your percentage of cures.

Dr. Cole. I do not know the experience of others, but we find that the eyes are rather sensitive to both *x*-rays and radium. I do not claim any credit for originating this method of treatment, for I noted it in the *Annals of Ophthalmology*. In all cases involving the lids we have a little brass ovoid 1 cm. thick which we first immerse in paraffin, then we cocainize the eye, fill the eye cavity with petrolatum liquidum, and slip this ovoid in under the lids. We can then ray the lids without any irritation of the eyeball itself. I think this is a point well worth remembering.

Dr. Pfahler. In these cases of epithelioma that have invaded the ear or the nose, I think we can get them all well if we do electrocoagulation. In the case the doctor reported with involvement of the cartilage of the ear, I think if he would add electrocoagulation he would cure it. In the pigmented melanoma, I have never seen a case so treated that has recurred, or become malignant.

Dr. Quigley (closing discussion). First, in regard to glands in lip cases: When I started in with this work nine years ago we did not know as much about it as we do today, so we did not ray the glands. I have been raying glands for a couple of years, and believe it is the right thing to do. I think we will get a better percentage of cures when we do this thoroughly and routinely.

In regard to melanomata and the metastasis in these melanotic growths: The latter are exceedingly widespread, they occur by way of the lymph-vessels and blood-vessels both, and they occur early. So I believe it has come to be quite commonly accepted that no cases of melanomata are cured. It is a question of destroying them while they are still local. Some of them do grow quite large before any metastasis takes place. Some metastasize early and grow rapidly. The thing that causes the pigmented mole to grow a while before changing into a malignant growth is usually some irritation, something which is operating to produce metastasis, and in most cases we get metastasis. But if we can get the malignant mole before metastasis has taken place, we can cure the patient.

THE TECHNIQUE OF THE TREATMENT OF CARCINOMA OF THE CERVIX UTERI WITH A COMBINATION OF X-RAYS AND RADIUM RAYS*

BY HENRY SCHMITZ, M.D.

CHICAGO, ILLINOIS

THE success of the radiological treatment of the deeply located cervical carcinomata depends on the solution of the problem: Is it possible to send into the interior of the true pelvis a dose of rays which is lethal to carcinoma tissue, yet will not cause permanent injuries to the healthy tissues and organs lying within the paths of the rays? The organs are the bladder, the rectum and the intestines.

The problem may be solved by determining:

1. The intensities of the *x*-rays and gamma rays of radium for the various distances. Thereby we are enabled to obtain the intensities of *x*-rays and gamma rays and, by a summation of these, the combined intensities at all points within the area of the body traversed by the rays.

2. A unit of dose which is based on a biological reaction. It is composed of the intensity and the time duration of the application of the rays.

3. A lethal carcinoma dose expressed in value of the biological unit of dose.

4. A technique of treatment based on the intensity of the rays, the biological unit of the radiation dose, and the lethal carcinoma dose.

1. *The Determination of Ray Intensities.* The intensities of *x*-rays are determined by the ionization method. We use the following factors for the production of the *x*-rays: A crest kilovoltage of 200 measured at the tube terminals with a sphere-gap of 12.5 cm. balls; a focus skin distance of 50 cm.; a filter of 1.0 mm. Cu. plus 1.0 mm. Al.; a field of 20 to 30 cm. square; a milliamperage of 5 and a large Coolidge treatment tube. The ionization chamber is placed on the surface of a water, paraffin or balsamwood phantom, so that one-half of the chamber is immersed in the phantom. The time is taken within which the ionization of the air in the chamber by the rays causes a discharge of the charged electrometer. The ionization chamber is next placed at a depth of 10 cm. from the surface. The time is again ascertained within which the electrometer is discharged.

The intensity at the surface is expressed in the time consumed to discharge the electroscope, i.e., I_0 is 14.2″; and the intensity at 10 cm. deep in the same way, i.e., I_{10} is 29.6″. If we place I_0 arbitrarily at 100 per cent then $I_{10} = \frac{14.2}{29.6} \cdot 100 =$ 48 per cent. The logarithmic graph of these *x*-rays which are practically homogeneous is a straight line. Hence, if we know the logarithmic values of two points of the straight, we know the values at any point. The logarithm of 100 is 2.0, and that of 48 is 1.68. The logarithmic values are entered on coordinates. The abscissae present centimeters and the ordinates the logarithmic values to the right and the per cent values of the intensities to the left. A line is drawn from 2.0 through 1.68. The natural numbers are read off at each centimeter. They represent the per cent of the intensity at each centimeter. We are now able to construct the absorption graph seen in II, Figure 1.

The intensities of gamma rays of radium are also obtained with the ionization method. We employ a chamber of the capacity of 0.5 c.c. and a gold-leaf electroscope. The conductors are constructed of brass tubing and a copper wire insulated with c.p. powdered sulphur and amber supports at the ends.

The quality of gamma rays depends on these factors: The amount of radium, the size and form of the capsules, the filters, the distance and whether the radium is applied to the surface of the skin, i.e., superficially, or within the tumor, i.e., intratumorally. In cervical carcinomata the insertions are intrauterine; hence we will only consider the intensities applied intratumorally. We placed two radium capsules each of 25 mg.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif. Sept. 12–16, 1922.

element in a brass filter of 1.5 mm. arranged as seen in Figure 3. The intensities are determined for each centimeter in the directions *a*, *b* and *c*, and corrected by the undesired radiation.

We then plotted the graphs of intensities seen in Figure 2. From these we constructed the isodoses or equal intensity curves seen in Figure 3 by simply placing the distances measured in the directions *a*, *b* and *c* at 100, 60, 40, 20, 10, 5 and 2.5 per cent on a plane.[1] We then had patterns made from each one of these equal intensity curves. If we draw a median longitudinal section in natural size from measurements taken of the patient, and enter thereon the *x*-ray beams and their intensities and the equal intensity curves of radium, we know the intensities of either one and the combined intensities at any place within the pelvis[2] (Figs. 4 and 5).

2. *The Biologic Unit of Dose.* If *x*-rays or gamma rays are applied to the human skin and the skin surface exhibits an erythema after fourteen to twenty-eight days, we have given an erythema skin dose. Using the same quality and quantity of radiations, we can reproduce the erythema skin dose at will. The quality of *x*-rays is determined by the factors enumerated above, and the quantity by the time duration of the application. The quality of the gamma rays is also known by observing the factors given before and the quantity of the gamma rays by the time duration of the application, usually expressed in milligram element hours.

It is self-evident that various therapeutists will obtain the erythema skin dose (E.S.D.) within variable time durations of applications, even though the quality of the rays be the same. Red is red. One might consider a light red a complete reaction, another one a deep red followed by desquamation of the superficial layers of the skin. Again, one transformer may give a full erythema skin dose within a shorter time than another. To eliminate such discrepancies it becomes necessary to employ standardized measuring instruments. With the iontoquantimeter we can determine the time duration of an application of rays to obtain a definite biological effect. Our instrument indicates an I_0 from the *x*-rays in 14.2″ using the factors enumerated before. If we change any one of the factors we obtain different values for I_0. If the value of I_0 is multiplied with the factor 6.32, we obtain a number indicating the number of minutes the patient must be exposed

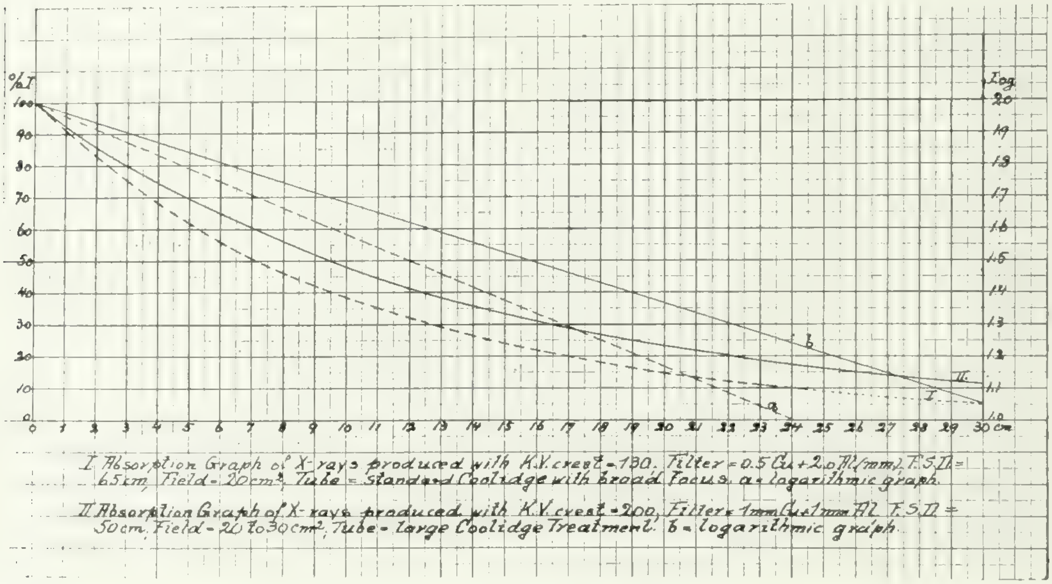


Fig. 1. By means of these graphs the per cent values of *x*-ray intensities may be read off for each centimeter.

to obtain a skin dose. Multiplying 14.2 with the factor 6.32 we obtain 90. We use 5 ma., hence the milliampere minutes amount to 450. This value gives the full 100 per cent erythema skin dose.

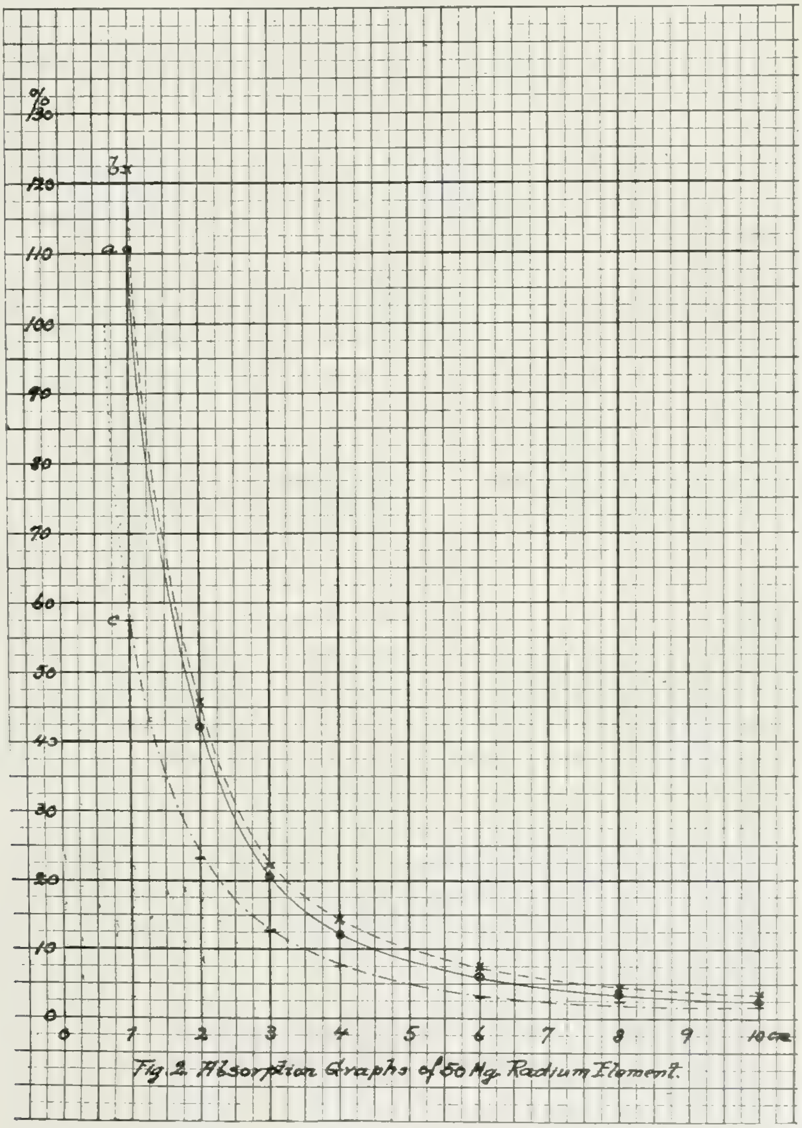


Fig. 2.

The E.S.D. of the gamma rays of the two radium capsules filtered with 1.5 mm. brass and placed as seen in Figure 3 has been determined as follows: A celluloid box 6 cm. square and 6 cm. high was filled with water. The radium carrier was kept at a distance of 1 cm. between the bottom and the outside of the filter. This corresponds to the isodose 60. The time duration of application to obtain a 100 per cent E.S.D. was twenty-four hours, or 1,200 mg. el. hrs. From these values the following 100 per cent E.S.D. may be calculated for each one of the isodoses:

Isodose	100.0	100 per cent E.S.D.	14 hrs. 24 min.	— 712 mg. el. hrs.
Isodose	60.0	100 per cent E.S.D.	24 hrs.	— 1,200 mg. el. hrs.
Isodose	40.0	100 per cent E.S.D.	36 hrs.	— 1,800 mg. el. hrs.
Isodose	20.0	100 per cent E.S.D.	72 hrs.	— 3,600 mg. el. hrs.
Isodose	10.0	100 per cent E.S.D.	144 hrs.	— 7,200 mg. el. hrs.
Isodose	5.0	100 per cent E.S.D.	288 hrs.	—14,400 mg. el. hrs.
Isodose	2.5	100 per cent E.S.D.	576 hrs.	—28,800 mg. el. hrs.

Knowing the E.S.D. in values of time duration of application or mg. el. hrs. for one of the isodoses, we can calculate the same factors for all the isodoses.

If we apply a 100 per cent E.S.D. to one of the isodoses, we can also calculate the intensities applied within the same time to all the other isodoses. Let us assume that we applied the radium for thirty-six hours, i.e., we have given a full E.S.D. to isodose 40. Hence

Isodose	40.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 100.00 per cent E.S.D.
Isodose	60.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 150.00 per cent E.S.D.
Isodose	100.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 250.00 per cent E.S.D.
Isodose	20.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 50.00 per cent E.S.D.
Isodose	10.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 25.00 per cent E.S.D.
Isodose	5.0	= application 36 hrs.	= 1,800 mg. el. hrs.	= 12.5 per cent E.S.D.
Isodose	2.5	= application 36 hrs.	= 1,800 mg. el. hrs.	= 6.25 per cent E.S.D.

Or we may intend to apply a 25 per cent E.S.D. at isodose 60. We obtain this intensity within six hours, i.e., 300 mg. el. hrs., as 100 per cent are obtained in twenty-four hours or 1,200 mg. el. hrs. The intensities obtained at the other isodoses with the 50 mg. ra. le. within the same time are:

At	60.0	25.0	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	100.0	41.65	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	40.0	16.66	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	20.0	8.33	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	10.0	4.16	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	5.0	2.8	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.
At	2.5	1.4	per cent E.S.D. within 6 hrs.	or 300 mg. el. hrs.

Friedrich has obtained different values for the E.S.D.[3] They are:

At	100.0	— 1,000 mg. el. hrs., or	20 hours
At	60.0	— 1,633 mg. el. hrs., or	35 hours
At	40.0	— 2,500 mg. el. hrs., or	50 hours
At	20.0	— 5,000 mg. el. hrs., or	100 hours
At	10.0	—10,000 mg. el. hrs., or	200 hours
At	5.0	—20,000 mg. el. hrs., or	400 hours
At	2.5	—40,000 mg. el. hrs., or	800 hours

3. *The Carcinoma Dose.* An application of an E.S.D. of gamma rays or *x*-rays to a skin cancer will cause the tumor to disappear, in the majority of cases. The healing is completed within three to six weeks. The skin assumes a normal condition. We can safely give a 130 per cent E.S.D. The result will be a blistering of the surrounding skin. Six to eight weeks later the cancer has disappeared and the skin is regenerated. A whitish discoloration and telangiectases are the sole evidences of the more intensive radiation. However, if about a 200 per cent E.S.D. is applied, the cancer will become replaced by a radiation ulcer which may heal under proper treatment or resist all forms of treatment. If the ulcer persists it must be excised and covered with a pedicled flap of skin.[4]

Applying the E.S.D. to mouth carcinomata, as the tongue, the buccal mucosa, the pharynx, the following result will be observed: The carcinoma apparently

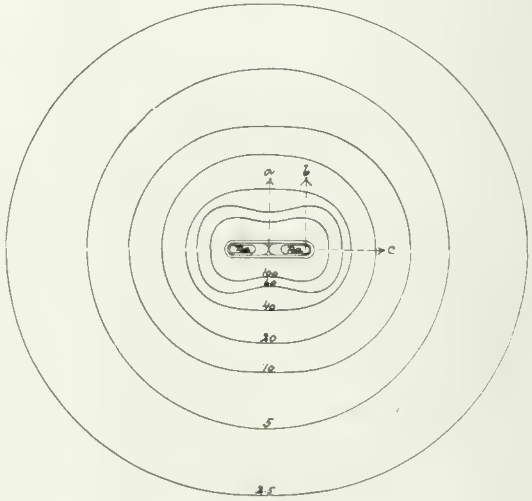
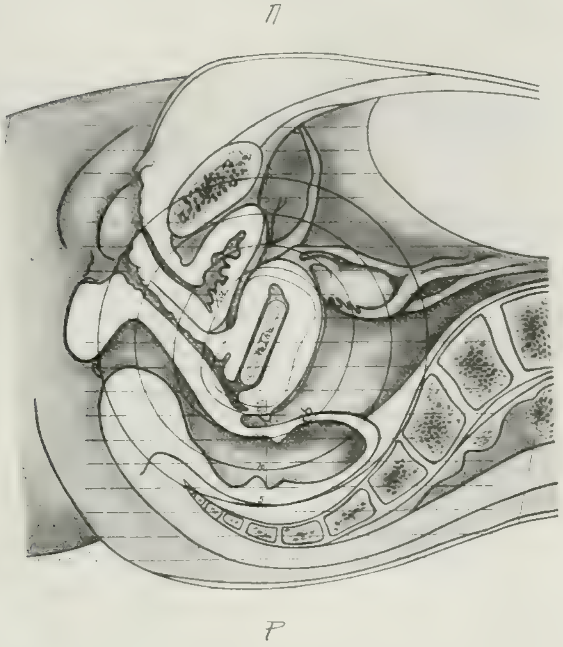


Fig. 3
Equal Intensity Curves of 50 Mg. Radium Element in Water

Fig. 3. Patterns made of these equal intensity curves may be drawn in transverse or longitudinal sections of the pelvic organs. Thus we know the correct intensities of the gamma rays through the pelvis.

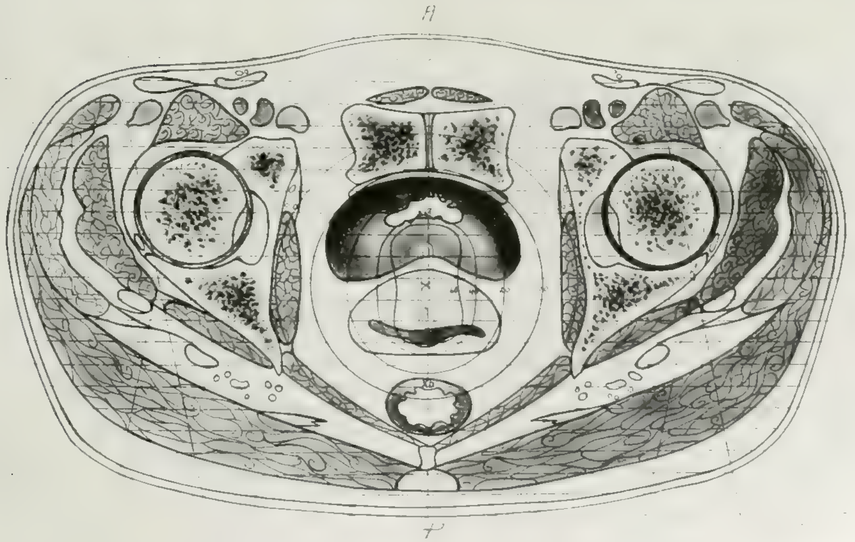


Intensities in Axis П-P

[illegible]	A	P	Total	Ra.I
0	100	20	120	
1	94	22	116	
2	87	24	111	
3	81	26	107	+1
4	75	28	103	+2
5	70	30	100	+4
6	65	32	97	+8
7	60	34	94	+16
8	56	36	92	+33
9	52	39	91	+50
10	48	42	90	
11	45	45	90	
12	42	48	90	
13	39	52	91	
14	36	56	92	
15	34	60	94	+50
16	32	65	97	+33
17	30	70	100	+16
18	28	75	103	+8
19	26	81	107	+4
20	24	87	111	+2
21	22	94	116	+1
22	20	100	120	

12 hours' application of 50 Mg. Ra El
[illegible] 50
40 33
20 16
10 8
5 4
Hence at [illegible] we have 10: 30·120
11+30·120

FIG. 4. The x-ray intensities and the equal intensity curves of radium on a transverse section.



0	100
[illegible]	94
[illegible]	87
[illegible]	85
4	75
5	70
[illegible]	65
7	60
8	56
9	[illegible]
10	48
11	45
12	42
13	39
14	56
15	54
16	32
17	30
18	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
21	22
22	20

FIG. 5. The summation of the combined x-ray and radium dose on a median longitudinal section.

recedes completely; however, recurrences are frequent. This is probably due to the fact that these regions are subjected to the normal functions of the body. This causative irritation soon excites a recurrence. Hence it is advisable to remove such carcinomata with surgical coagulation following radiation treatment, if we wish to obtain permanent results. If the glands of the neck and jaws are subjected to such intensive radiations, the secretions of important glands are destroyed, due to the destruction of these organs. They are chiefly the pituitary, parotid, submaxillary, sublingual, thyroid and parathyroid glands. The patient, after an apparent recovery, begins to fail in health. Not a sign of the former carcinoma may be present. Yet the patient succumbs to a progressive emaciation. The balance of the endocrinal system has been disturbed, and the patient cannot live.[5]

We may apply a full dose to a chest cancer. The patient may exhibit signs of a radiation toxemia; the blood changes also may be pronounced. Yet the intensity of these reactions is seldom dangerous to life. If we give radiation treatment to the abdominal cavity, important glandular structures are traumatized, such as the adrenals and the pancreas. We should always attempt to protect one of the adrenals by superimposing a sheet of lead over one of the renal areas, especially if we treat a pyloric carcinoma. This is accomplished by tilting the patient towards the left. We then can avoid the right adrenal gland. Toxemia, vomiting and diarrhea, also, are pronounced. They result from the direct action of the rays on the gastrointestinal tract and the indirect action of the rays producing toxic substances liberated by the action of the rays on the cells. The latter are a gastrointestinal poison. Weeks pass by before the patient regains a tolerable state of health. During this period he cannot activate the defensive forces necessary to increase the avidity of the normal cells, thus enabling the latter to absorb the degenerating carcinomatous neoplasm. The stomach and intestines are also subjected to the same causative irritations, i.e., the normal physiological functions, unless we can exclude the diseased part from the gastrointestinal tract by surgical intervention, as gastrojejunostomy, enteroenterostomy, colostomy, etc. The conditions in the urinary tract are identical with those in the gastrointestinal tract. The changes in the blood also might be very severe, but could be overcome by transfusions of whole blood.

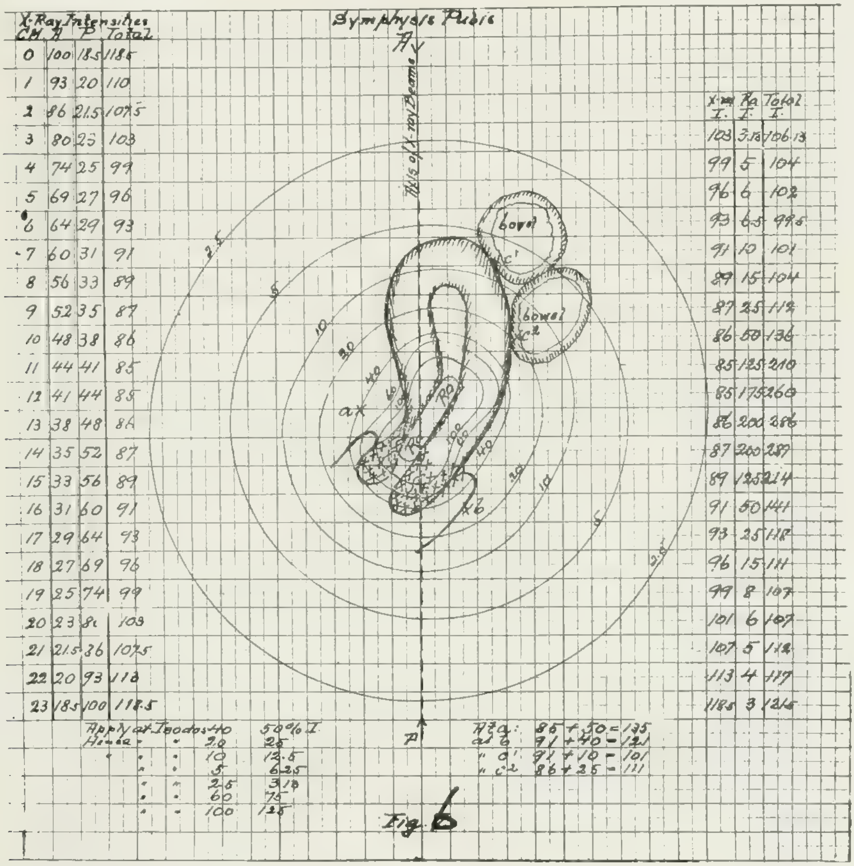
These detrimental factors are not found in uterine carcinomata. Important ductless glands are not located within the radiation fields, except the ovaries. The uterus is destroyed, ovulation and sexual activity, i.e., the physiological functions cease. The fields of radiation must be just large enough to cover the small pelvis, thus to reduce the injuries to the blood stream and intestinal mucosa. Still we observe toxemia and leukopenia, at times of an alarming degree. On the whole, however, the patient recovers and progresses to perfect health.[6]

These facts are stated to impress you with the importance of practicing an exact dosation. When applying the roentgen rays, the field must be just large enough to cover the diseased area. The rays are dangerous, and we must not employ them promiscuously. We should not apply more than 450 to 600 ma. min. of a 200 kv. radiation, or radium above an erythema skin dose beyond the isodose 40, and much smaller amounts, if *x*-rays and gamma rays are being used in combination. The carcinoma should be destroyed with the smallest lethal dose that will do the work. By the combined use of *x*-rays and gamma rays we are able to reduce the time of application of either agent. The systemic intoxication, the injuries to healthy tissues and organs and the destruction of blood corpuscles are kept at a minimum. A simple calculation will demonstrate that we would have to increase the milliampere minutes of *x*-rays up to 100 per cent to obtain a 130 per cent E.S.D. at the cervix. We must use from 750 to 900 ma. minutes over each field, i.e., the anterior and the posterior field. The technique of the combined radiations, therefore, reduces the time of *x*-ray exposure at least 50 per cent.

The greatest danger from radium is its local destructive effect. This absolutely prohibits exposures that could destroy carcinoma tissue beyond a radius of 2.5 cm. Again the time duration of the application of radium can be kept within safe limits by the technique of the combined radiation.

It therefore, is our custom to apply the *x*-ray so to obtain a 120 to 130 per cent E.S.D. on the skin over each one of the two ports of entry and supply the deficiency within the region of the uterus by such a gamma ray dose that a homeogeneity of 110 to 130 per cent E.S.D. is obtained within the area radiated, though the uterus might receive a much higher dose with impunity.

In the preceding paragraphs I have not referred to the variations in radiosensibility of carcinomata which are dependent on the epithelial-cell type and the abundance of the connection tissue frame-work of the tumor. We must concede that the basal-celled epithelial cancer reacts more rapidly to radiations than the hornifying epithelioma, the cylindrical epithelial cell growth or the adenocarcinoma. The medullary carcinoma responds much sooner to radiations than the scirrhus type. The former is composed almost totally of embryonal cells, and the latter exhibits a varying proportion of adult differentiated tissue.



X-Ray Intensities CM.	R	P	Total
0	100	18.5	118.5
1	93	20	110
2	86	21.5	107.5
3	80	23	103
4	74	25	99
5	69	27	96
6	64	29	93
7	60	31	91
8	56	33	89
9	52	35	87
10	48	38	86
11	44	41	85
12	41	44	85
13	38	48	86
14	35	52	87
15	33	56	89
16	31	60	91
17	29	64	93
18	27	69	96
19	25	74	99
20	23	80	103
21	21.5	86	107.5
22	20	93	113
23	18.5	100	118.5

X-ray I.	Ra I.	Total I.
103	3.13	106.13
99	5	104
96	6	102
93	6.5	99.5
91	10	101
89	15	104
87	25	112
86	50	136
85	125	210
85	175	260
86	200	286
87	200	287
89	125	214
91	50	141
93	25	118
96	15	111
99	8	107
101	6	107
107	5	112
113	4	117
118.5	3	121.5

Apply at	Isodos		40	50% I
Hence	"	"	20	25
	"	"	10	12.5
	"	"	5	6.25
	"	"	2.5	3.12
	"	"	60	75
	"	"	100	125

R at a: 85 + 50 = 135
at c 91 + 40 = 131
" c' 91 + 10 = 101
" c2 86 + 25 = 111

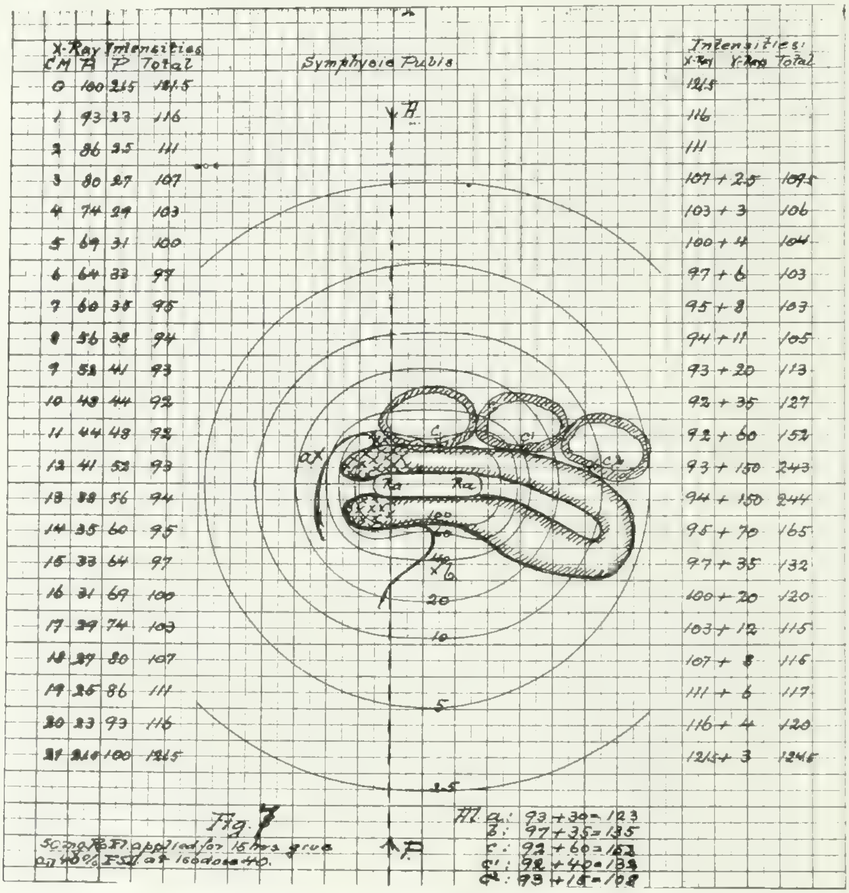
Fig. 6. The application of the problem in actual practice. The uterus is in anteversion.

However, a lethal carcinoma radiation dose exists which will cause degeneration and recession of the cancer in the greater majority of cases subjected to this treatment.

4. *The Techinque.* The uterus is contained within the true bony pelvis. The widest extent of the carcinoma may be assumed to be confined to this space. If the inferior and superior lumbar lymph-nodes are involved, the cancer disease has

become generalized. Such a case is hopeless. The axis of the uterus corresponds, in most instances, to the axis of the true bony pelvis. The cervix lies in a straight line drawn vertically through the superior ramus of the symphysis pubis and posteriorly through the sacrococcygeal synchondrosis. The axes of the *x*-ray beams should lie within this line. We determine the anteroposterior diameter of the pelvis of the patient. It varies from 15 to 26 cm. Values lower or higher than these are the exception. About 60 per cent of women have anteroposterior diameters of 18 to 21 cm. We also locate the position of the cervix by measuring its distances from the anterior abdominal wall and the perineum. The former distance is mostly two-thirds of the total anteroposterior diameter. We use a modified pelvimeter measure the anteroposterior diameter and the depth of the cervix. The length and inclination of the uterus are determined by a flexible uterine probe. The results of these measurements are plotted on centimeter paper (see Fig. 6). We enter in column 1, the centimeters; in column 2, the *x*-ray intensities given through the anterior field for each centimeter by means of graph II in Figure 1; in column 3, the *x*-ray intensities given through the posterior field; and in column 4, the sum of *x*-ray intensities obtained at each centimeter with both beams.

We then draw the radium capsule in an exact position in the uterine canal and by means of the patterns of the equal intensity curves we enter the isodoses. The posterior bladder wall and anterior rectal wall are then indicated by the stars at



X-Ray Intensities

CM	A	P	Total
0	100	21.5	121.5
1	93	23	116
2	86	25	111
3	80	27	107
4	74	29	103
5	69	31	100
6	64	33	97
7	60	35	95
8	56	38	94
9	52	41	93
10	48	44	92
11	44	48	92
12	41	52	93
13	38	56	94
14	35	60	95
15	33	64	97
16	31	69	100
17	29	74	103
18	27	80	107
19	25	86	111
20	23	93	116
21	21.5	100	121.5

Intensities:

X-Ray	Y-Ray	Total
121.5		
116		
111		
107	+ 2.5	109.5
103	+ 3	106
100	+ 4	104
97	+ 6	103
95	+ 8	103
94	+ 11	105
93	+ 20	113
92	+ 35	127
92	+ 60	152
93	+ 150	243
94	+ 150	244
95	+ 70	165
97	+ 35	132
100	+ 20	120
103	+ 12	115
107	+ 8	116
111	+ 6	117
116	+ 4	120
121.5	+ 3	124.5

Fig. 7. Another example. However, the uterus is in retroversion.

a and *b*. The loops of intestines are marked *c*, c^1, and c^2; *a* and *b* are usually 2.5 cm. distant from the cervical canal, if the bladder and rectum are empty. If the bladder and rectum are distended, they are forced closer to the cervical canal. This must be avoided. Hence the bladder is kept empty by the use of a retention catheter and the rectum by castor-oil and enemas and a liquid diet.

The posterior bladder wall and the anterior rectal wall are the locations mostly and irreparably traumatized by injudicious radiations. The maximum dose that the vesical and rectal mucosae will bear without permanent injuries is 130 per cent of an E.S.D. We therefore must attain a dose of 130 per cent or less at points *a* and *b*. The dose should not exceed this limit, under any conditions. Overdosation causes stricture of the rectum and contraction of the bladder, resulting in vesical and rectal tenesmus, and frequently, in rectal stricture and bladder contraction. If the dose has been too large, necrosis occurs with the formation of vesico- and recto-vaginal fistulae. Such results cloud the success of radiation therapy. The patient, though relieved of the cancer disease, has exchanged her primary invalidism for another one of at least the same intolerability.

The *x*-ray dose at *a* is 76 per cent of an E.S.D. and at *b*, 82.5 per cent. The additional intensity of radium to bring the dose to 130 is, therefore, 50 per cent. Points *a* and *b* lie about midway between isodoses 40 and 20 at about the isodose 30. If we apply a 100 per cent E.S.D. dose with gamma rays at isodose 60, we obtain a 50 per cent E.S.D. at isodose 30. It means that we must insert the radium for twenty-four hours. The doses obtained at the other isodoses are as follows:

At isodose 60 a dose of 100 per cent by applying 1,200 mg. el. hrs.
At isodose 100.0 a dose of 166.5 per cent
At isodose 40.0 a dose of 66.6 per cent
At isodose 30.0 a dose of 50.0 per cent
At isodose 20.0 a dose of 33.3 per cent
At isodose 10.0 a dose of 16.7 per cent
At isodose 5.0 a dose of 8.3 per cent
At isodose 2.5 a dose of 4.2 per cent

The combined doses at each centimeter are entered in the columns to the right in Figure 6, demonstrating that with a combined use of radium and *x*-rays a radiation dose can be administered destructive to the uterus and the carcinoma without injury to the neighboring healthy organs and tissues. The doses beyond *a* and *b* anteriorly as well as laterally, are always smaller than the doses at these points.

Let us consider another case of cervical carcinoma in which the uterus lies in retroflexion. The bladder is now forced closely on the vaginal portion of the cervix; the fundus compresses the rectum posteriorly; the intestines lie upon the anterior surface of the uterus. We force the bladder and rectum away from the cervix by distending the anterior and posterior vaginal fornices with gauze pads. The small bowels are so close to the radium capsule (about 2 cm., i.e., the thickness of the anterior uterine wall) that they probably will receive too large a dose. However, even if a perforation should result, the peritoneal adhesions will protect the patient. The liquid chyle has no difficulty to pass the bowel, should it become constricted. The solution of such a problem is seen in Figure 7.

SUMMARY

1. The methods for the determination of the intensities of *x*-rays and gamma rays have been described.
2. A definition of the biological unit of the radiation dose has been given. It is designated as a 100 per cent E.S.D. This dose is measured with an iontoquantimeter, that is, standardized. The same dose, therefore, may be reproduced for all qualities of rays.
3. The lethal carcinoma dose has been determined. It is, on an average, from 110 to 130 per cent of an E.S.D.
4. A technique has been developed, based on these investigations, which enables anyone to solve the problem of the successful treatment of cervical carcinomata with the combined use of *x*-rays and gamma rays of radium.

BIBILOGRAPHY

1. Schmitz, H., and Huth, E. The Determination of Equal Intensity Curves of Short Radium Capsules. New York, 1922.
2. Bachem, A. Die physikalischen Grundlagen der Uterusbestrahlung und die kombinierte Röntgen

und Radiumbehandlung. *Strahlentherapie*, 1921, xii, 979.
3. Opitz, E., and Friedrich, W. Die Freiburger Strahlenbehandlung des Uteruskrebses. *München. med. Wchnschr.*, 1920, No. 1, p. 1.
4. Kroenig, E., and Friedrich, W. The Physical and Biological Principles of Radiation Therapy. New York, 1922.
5. Brock, Walter. Welche Bedingungen sind massgebend für die Röntgenbehandlung der Hautkrebse? *Strahlentherapie*, 1921, xiii, 1.
6. Opitz, E. Biologisches zur Strahlentherapie. *München. med. Wchnschr.*, 1922, lxix, 917.

DISCUSSION

Dr. Ernst. I think it has been a privilege to listen to the paper of Dr. Schmitz and also to read over many of the papers, especially the one by Dr. Opitz of Berlin.

In looking over the conclusions it does seem, with some exceptions, that perhaps the best we can say for the present time is that the more intensive present methods of radiation with the more homogeneous rays do give us better results, but having reached this conclusion it seems that our troubles have just begun.

Dr. Schmitz' work is certainly commendable from the viewpoint that it tries to give more exactly the dose we ought to give to protect those structures which perhaps need protection. I firmly believe that it is a question of keeping our dose within the range of the minimum and maximum.

I have a few little extracts here from Dr. O— which I think are worth while considering. He makes the following definite statements: He speaks of the retrogression of cancer as not being due solely to immediate action of the rays. He further states as to the question of cancer dose that there is, according to S & R, at the present time no curative or definite dose such as 90 or 100 per cent erythema. However, he states that in the majority of cases of mammary and uterine cancer retrogression may be expected from administration of such a dose. He likewise presents another interesting observation with reference to the principle of radiotherapy in cancer of the breast and uterine conditions, and refers to a large series of treatment cases showing cure of five or more years and manifested only by slight erythema on the skin. He examined all of those cases and noted the results, and then examined cases in which there was marked erythema, and the condition of these cases was considerably more pronounced. He is very emphatic in the statement that an overdose should be considered dangerous as it weakens the local cells which are the defensive forces of the body.

Now as to the question of the amount of radiation at one time; O—— prefers giving frequent radiation from six to eight weeks with doses slightly less than the maximum cancer dose. With this method of divided doses many of us do not altogether agree, although I feel there must be some merit in such a technique.

In about 25 per cent of the cases we have been treating in the past ten months, by force of necessity we had adopted such a course and I was surprised at the rather marked improvement over the single doses which we would like to give and think ideal; but that question of the amount of radiation and the question of staying within the limits of the maximum and minimum radiation is certainly something we must consider carefully.

The value of both the radium and the *x*-ray together with the anatomical situation of pelvic conditions is certainly of importance to all of us. However, any method or methods adopted certainly should be adjusted to the conditions of the individual case, and we should make every effort to keep within the boundary of the minimum and maximum dose.

Dr. Martin. I would like to ask about this 135 per cent dose that Dr. Schmitz spoke of as being safe for the intestine. I would like him to tell us definitely how he knows positively that 135 per cent is safe for the human intestine. I do not feel it sufficient to measure dosage with the iontoquantimeter and make a definite decision on the biological reaction therefrom.

Dr. Chamberlain. If Dr. Schmitz thinks it worth while he might say something about idiosyncrasies. We heard a great deal about this and as measuring devices and methods became more accurate we heard less and less about idiosyncrasies. Lately we have been hearing more about it again and it seems to some of us that as the measuring methods again catch up with the apparatus that we will hear less of idiosyncrasies,—at least as regards very marked or important degrees of variation in susceptibility.

Dr. Schmitz (closing). We have treated about 300 cases with the new therapy and about 50 with the old. From clinical experience we know what happens. In examining our patients we invariably make a bladder and proctoscopic examination; so we know exactly the condition of the organs before and after radiation. With our present methods we have never seen permanent secondary effects in the small intestine. However, I do not think that would hold good. I can only say that with this new method we have had only one result. Patient died three days after radiation directly from the effects of the radiation. I used very poor judgment in giving one full dose anteriorly, causing a degeneration of a large amount of tissue which killed the patient, but it was not due to intestinal disturbance.

The question arose. How did I determine the 135 per cent erythema skin dose? If you multiply the seconds which are necessary for dosage of certain ?? of x-ray by 35 per cent you get the erythema skin dose. F—— says 90 per cent skin dose will kill cancer. The ratio between the G——— and F——— dose is five to ten. My skin dose is actually three times larger than G—— and twice as large as F——. G——, with this technique, gives three series of treatments six weeks apart. At each time he radiates the same fields. We only give one series of treatments and never repeat a treatment, and we are sure this does no permanent injury to the skin.

In regard to idiosyncrasies,—if you treat a case of smallpox you know it takes a definite amount of units of antitoxin to do the job and that is the average dose for a patient, and yet you will find cases where you will have to increase the dose and others where you must make it smaller. It is the same with x-rays. By experimental work you determine your patient's needs. Some patients might receive too much, but finally the patient has cancer and there is very little lost.

A NEW RADIUM CHART

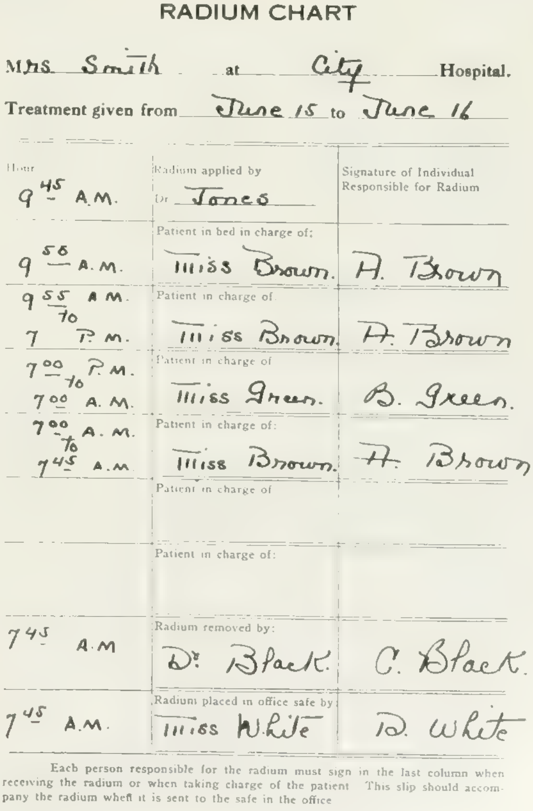
BY LAWRENCE A. POMEROY, M.D., F.A.C.S.

CLEVELAND, OHIO

RECENT changes in the provisions of many policies covering the loss of radium make it desirable to know definitely what house officer or what nurse is responsible for the radium during the different portions of the entire time consumed by one treatment. To aid in obtaining and recording this data the following chart has been devised.

In the first column the time is recorded in hours and minutes. In the second column the operator writes the name of each nurse opposite the time she is to be in charge of the patient. In the third column the nurse is to sign her name when she receives the radium or assumes charge of the patient. This plan provides a written receipt for the radium from the time it is applied to the patient until it is removed and placed in the hospital safe.

If the patient is in a ward, and not in charge of a special nurse, the use of this chart shows definitely what nurse is responsible for the patient and the radium at any given time.



RADIUM CHART

Mrs Smith at City Hospital.

Treatment given from June 15 to June 16

Hour	Radium applied by	Signature of Individual Responsible for Radium
9^{45} A.M.	Dr Jones	
9^{56} A.M.	Patient in bed in charge of: Miss Brown.	A. Brown
9^{55} A.M. to 7 P.M.	Patient in charge of Miss Brown.	A. Brown
7^{00} P.M. to 7^{00} A.M.	Patient in charge of Miss Green.	B. Green.
7^{00} A.M. to 7^{45} A.M	Patient in charge of: Miss Brown.	A. Brown.
	Patient in charge of	
	Patient in charge of:	
7^{45} A.M	Radium removed by: Dr Black.	C. Black.
7^{45} A.M.	Radium placed in office safe by: Miss White	D. White

Each person responsible for the radium must sign in the last column when receiving the radium or when taking charge of the patient This slip should accompany the radium when it is sent to the safe in the office

THE TREATMENT BY RADIATION OF CANCER OF THE RECTUM*

BY HARRY H. BOWING, M.D., AND FRANK W. ANDERSON, M.D.

Section on Radium and Roentgen-Ray Therapy, Mayo Clinic

ROCHESTER, MINNESOTA

I WAS asked by the Program Committee of this Association to present a paper on the end-results of treatment by radiation of cancer of the rectum. After considering the matter, I decided that statistical data of value could not be obtained in so short a time. Moreover, the topic was being investigated in the Clinic from the surgical standpoint. I decided, therefore, to confine my discussion chiefly to a description of the technique as it is used in the Mayo Clinic.

Da Costa, before a recent meeting of the American College of Surgeons, said that in his experience, radium relieved pain, and that in certain cases in which the growth seemed hopeless, it did give hope. He expressed the belief that radium, used with the knife, with sound clinical judgment, could be recommended as a valuable adjunct, but that a physician who uses radium for all cases is as much a menace to the public as the physician who uses strychnin or the roentgen rays for all diseases.

Recently, W. J. Mayo mentioned that he is favorably impressed with the results of a combination of surgery and radiation in the therapeutic management of rectal carcinoma. He recalled several inoperable cases which became operable following radium exposures, and deplored the fact that many physicians are giving radium treatments with little or no experience, and in many instances with insufficient radium.

Hayward Pinch expresses the opinion held by all competent radiologists as follows:

"It is to be regretted that within the past twelve months statements have been published in the lay press to the effect that radium is a failure, and these appear to have originated in the pronouncements of some well-meaning but ill-informed practitioners concerning a subject of which they possess but very little personal experience. As these statements are not infrequently alluded to by patients and their friends, it is obvious that considerable harm has been done by their dissemination, and it therefore appears desirable strongly to controvert the assertion. Radium is not a failure when used intelligently and scientifically, and applied to the treatment of those conditions which experience has shown are amenable to its action. No honest worker claims, or has ever attempted to claim, that radium is to be regarded as a panacea, or as a cure for malignant disease, and many years must elapse and much more research and clinical work be done, before it will be justifiable to use the word 'cure' even in selected cases of malignant trouble. It is best, therefore, to speak only of 'arrest of the disease,' and this can be truthfully affirmed in very many instances. Patients whose lives would have speedily terminated, and who would have suffered much intense agony, have been enabled by radium treatment to live for many years in comparative comfort after all the known resources of medicine and surgery had been exhausted. That in radium we possess an addition to our armamentarium of great value, is a fact which cannot be challenged, and it is distressing to think that a rash and ill-advised statement, by its wide publicity, should have deprived many patients of fresh hope and possible benefit."

Levine has said, "Surgery, while meeting with some degree of success, has not solved the cancer problem. A comparative analysis of vital statistics and cancer statistics shows that in the hands of different surgeons, the highest percentage of all cancer cases of a community which can be cured by surgical treatment is 15.25 per cent, and the lowest 4.15 per cent, or, in all probability, less than 10 per cent."

---

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

Radium, when properly applied, will bring about a definite inhibitory and destructive effect in the majority of rectal neoplasms. There is an abundance of evidence available to prove it to be a valuable adjunct when added to our present surgical procedures to combat rectal cancer, and that, in selected cases, it should be used as a pre-operative and postoperative measure.

The impossible is usually expected of radiation therapy. The majority of patients are beyond the aid of surgery or any recognized method of treatment. Many cannot be treated intensively. The majority of patients, three and five years ago, received inadequate and poorly applied treatment, when compared to our present methods. These factors make statistical study practically valueless.

The day is not far distant when cases will be classified as favorable or unfavorable for radiation therapy. The lesion may be grouped as one responding to radiation, but its location, extent and special characteristics will not permit of thorough treatment. The chief element of defeat is the lack of sufficient exposure of the tumor.

More than 300 cases in the Mayo Clinic have been treated. The majority were inoperable and only a reasonable amount of placebo treatment was given. Many of the treatments were postoperative and prophylactic. Some of the cases were recurring following radical surgical procedures. Twenty or more patients received pre-operative radium exposures. One or more, whose cases were operable, decided in favor of radium. In about 6 inoperable cases a radical posterior resection was performed after radiation therapy. No added surgical difficulties are recorded. A few patients stand out as receiving sufficient treatment to arrest the process.

McVay, in a study of 100 patients operated on in the Mayo Clinic for cancer of the rectum, made observations as follows:

"The anorectal lymph-glands are four to eight in number and are situated on the posterior and lateral walls of the rectum. The size of the growth in the rectum cannot be relied on as an accurate index to the probable lymphatic involvement. Without lymphatic involvement there is a tendency of the growth to expand into the lumen of the bowel. The growths with some lymphatic involvement tend to spread by direct extension, and are slow growing. Carcinomas of the rectum, with extensive glandular involvement, tend to metastasize through the lymph stream early. Occasionally metastasis may take place by emboli breaking off into the portal vein. Rectal carcinoma is the most common form of intestinal growth, and represents 5 per cent of all cancers of the body. It is more common in men than in women.

"Metastatic involvement of the glands can only be definitely determined by systematic microscopic study of all the regional lymph-nodes. The size of the node is not an efficient means of determining whether or not there is metastatic involvement. This is particularly true if the amount of involvement is small or if the process is early."

Most cancers of the rectum are adenocarcinomas; the growth may be: (1) Bulky with partial or complete involvement of the walls of the rectum; (2) tabular with partial or complete involvement of the walls; (3) smooth, annular, and contracting with nearly complete obstruction; (4) multiple, occurring as polyposis. Each group presents difficulties for the radiologist. Each patient must receive individual treatment with applicators adapted to fit the requirements of intensive therapy. The cases can readily be classified into three groups:

I. *Operable Cases.* A digital, and in some instances, a proctoscopic examination, made the diagnosis. Exploration of the abdomen showed an operable growth in the rectum with no gross distant metastasis. A left rectus colostomy was made, and, a few days later, radical posterior resection was performed. As soon as surgical convalescence permitted, the deep end of the distal colostomy loop and the posterior resected area were treated with filtered radiation. Twenty-two patients received radium before resection; that is, two to three applications at intervals of two or three days. At the end of two weeks following the first application, the resection was performed. One patient refused operation. Bare glass tubes were buried in the growth. A few other patients, on account of some contraindication to a general anesthetic or too great operative risk, received only radium treatments.

II. *Inoperable Cases.* The diagnosis was determined by either digital or proctoscopic examination, and in borderline cases, an exploration was made. A few operable cases, on exploration, revealed distant metastasis, or a second growth high in the rectosigmoidal area. The most outstanding subdivisions of this group are the few cases in which sufficient reduction of the tumor was obtained by radiation to warrant posterior resection. In some, a thorough microscopic search of the structures removed did not disclose cancerous tissue. I found 3 similar cases reported in the literature.

The first reported case of excision for cancer of the rectum following radium treatment was observed by Symonds in 1914. The patient, a man, aged seventy-three years, had an annular growth 4 cm. from the anus; on section it was found to be carcinoma. On five consecutive days, for six hours each, 100 mgm. of radium was applied, screened with 2 mm. lead and 3 mm. rubber. Eleven days later, visual and palpable examination revealed that the growth had disappeared and only a ring of cicatricial tissue was present. Six months and twenty-six days after the application of radium, a perineal resection was performed. The proximal end of the rectum was sutured to the anal portion and the sphincter was saved. Complete union followed. One month later, the colostomy was closed. Microscopic sections did not reveal the presence of active carcinoma.

The second case observed was reported by Handley. The patient, a man, aged sixty years, had a small bleeding area 12.5 cm. from the anus. Specimens removed for examination proved to be carcinomatous. The condition was considered inoperable. On September 6th, with the aid of a sigmoidoscope, 150 mgm. radium bromid, filtered through 2 mm. platinum was applied to the stricture above the ulcer area for nine hours. It was then applied to a higher area for twelve hours, and to a lower area for ten hours.

Two weeks later, a severe local reaction occurred, but one month after treatment, the bleeding and pain had ceased. At this time, edges of the ulcer were flat, and the stricture appeared to be simple. Two months after the radium treatment, colostomy was performed, and the growth removed. At operation, 160 mgm. radium bromid filtered with 1 mm. silver, 2 mm. platinum, and 2 cm. gauze was applied in the abdominal wound for twenty hours, and 50 mgm. radium bromid filtered with 1 to 2 mm. silver, 1 mm. lead, and 4 mm. gauze in the perineal wound.

A large abscess in the right side of the pelvis had to be opened on the tenth day, and there was some suppuration in the abdominal and pelvic wounds. Sixteen days after operation, 150 mgm. radium filtered as previously was applied high in the pelvic sinus for twenty hours. One year later, the patient was in good health.

The third case reported was observed by Durand. The patient, a man, aged fifty-four years, had a circular neoplasm 2 cm. from the anus. The canal barely admitted the finger, and extirpation appeared difficult. One hundred and ten milligrams of radium was applied for forty-four hours. Five weeks later, a "Lisfranc operation" was performed. No added surgical difficulties are recorded. The lesion was found to be greatly modified and almost cicatrized.

III. *Recurring Cases.* The patients in this group had had radical resections, and some of them had had radium treatments postoperatively. They returned for further observation and treatment at varying intervals following operation. A few received marked palliative relief, and some were seemingly in good health. The relief from obstruction, the absence of bleeding, the lessening of pain, etc., account for the initial improvement. It is not easy to establish a diagnosis of recurrence. The character of the discharge may help; if possible, a small specimen should be removed for microscopic examination. In 1 or 2 patients in this group in whom recurrence was suspected, a hypodermic needle was introduced into the mass with the escape of pus. With sufficient drainage, the condition cleared up.

TREATMENT

Cancers of the rectum are difficult to treat, since the tumor is incased in the bony pelvis with only a small contracted sinus in which to place the radium. If the inguinal glands are enlarged, they should be treated as metastatic processes. The radium is applied to the skin surface overlying the enlargement.

The treatment should be individual. I am confident that certain groups of patients cannot be treated according to a therapeutic framework. Every avenue of approach should be used in order thoroughly to radiate the tumor. The vaginal mucous membrane tolerates radium rays very well. If the rectal mass can be palpated by vaginal examination, the cavity should be packed with radium. The treatment should be either prophylactic or intensive, as the case demands.

Technique. The technique of radium application should be simple and yet consistent with good treatment. The applicator must remain as placed for the allotted time; this is assured by making the patient as comfortable as possible. The applicator should be designed so that it can be fixed to the body surface, to insure constant exposure of the tumor, and avoid accidental injury to adjacent normal tissue. The tumor tissue, if properly radiated, loses all morphology and is replaced by fibrous connective tissue. Overradiation should be avoided, especially in cases in which radical removal is under consideration in order to avoid added surgical difficulties. In selected cases, pre-operative radiation and a sufficient time interval before the radical removal will improve the case for surgery and give greater assurance against local recurrences. It will reduce to a minimum the chance of dissemination, since the primary growth has been almost completely devitalized, and has lost all power of rejuvenation. This has been proved by microscopic examination of specimens removed from the original tumor area (Figs. 1, 2 and 3). A minimal amount of exposure of doctor and nurse in preparing and placing the applicator should be an important factor in the construction of the applicators, and they have been adapted with these factors in view.

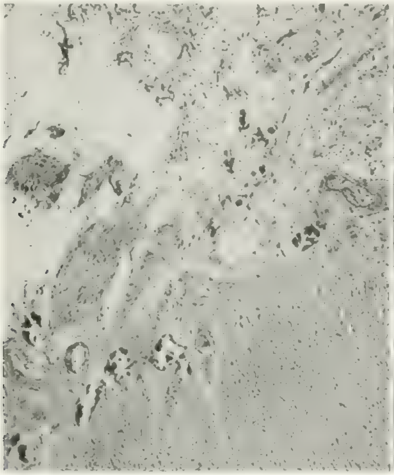


Fig. 1. Remains of carcinoma and musculature of rectum and apparent direct extension from primary carcinoma tissue completely devitalized.

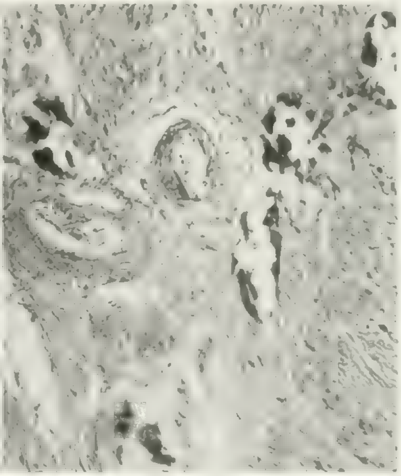


Fig. 2. High power of Figure 1.

No distinction is made between the applicator containing a salt of radium, and a tube of radium emanation prepared by the Duane series of mercury pumps. Radium C, with its alpha, beta and gamma rays is the therapeutic principal, regardless of its source. The Universal tube applicator with walls of silver 0.5 mm. thick, containing 50 mgm. radium sulphate by measurement, may be used, or a modified tube applicator (Fig. 4, No. 2) with walls of brass equal in filtration to the silver tube, into which are placed small glass tubes containing emanation. The tubes usually measure 50 to 75 mc. The applicator shown in Figure 5, No. 2, is suited for the treatment of small and narrow sinuses, and can be introduced into drainage tubes at operation. The stem will bend to suit the contour of the body, and can be fixed with adhesive plaster.

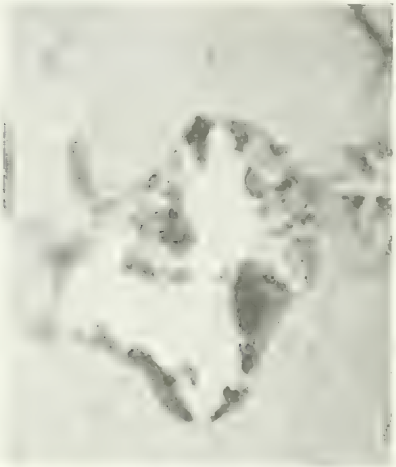


Fig. 3. Remnants of devitalized nuclei, impossible of regeneration.

To the stem (Fig. 5, No. 3) which has been devised to accommodate the Universal silver tube applicator, a brass shell is fixed with very thin walls, for it is not intended to act as a filter. A Para rubber tube, with walls 1.5 mm. thick, fits over the shell and extends 5 to 8 mm. beyond the end. This holds the radium tube in place and affords a soft rubber tip for the applicator, which will prevent undue trauma. It may be used similarly as the applicator shown in Figure 5, No. 2, but its extra bulk limits its application. It is the one of choice in treating a bulky tumor with a sinus of the rectum. With the index finger it can be easily directed through a tortuous canal common to bulky tumors.

The applicator (Fig. 5, No. 1) can be introduced easily. It is very efficient in the treatment of the deep end of the distal colostomy loop; if used in this way, the brass filter is added (Fig. 4, No. 1). The wire stem permits easy introduction and secures fixation to the body surface.

The instrument shown in Figure 4, No. 6 is a modification of the soft rubber rectal Walles bougie. The unmodified bougie is very uncomfortable to wear for any length of time. Some patients will not tolerate it at all. It does not permit accurate introduction, since the index

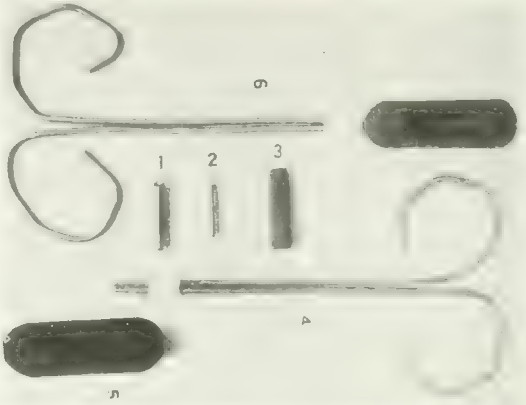


Fig. 4. No. 1. Universal silver filter with walls 0.5 mm. thick. No. 2. Modified Universal tube applicator; the walls are brass. No. 3. A rubber filter with wall 3 mm. thick. No. 4. A stem of solder wire 40 cm. long, with a small piece of adhesive tape around the tip to keep the stem from slipping through the canal in the rubber filter. No. 5. Part of a soft rubber Wales bougie (No. 10 or 12). The window accommodates one Universal tube applicator with or without the brass filter. No. 6. A modification of the soft rubber Wales bougie.

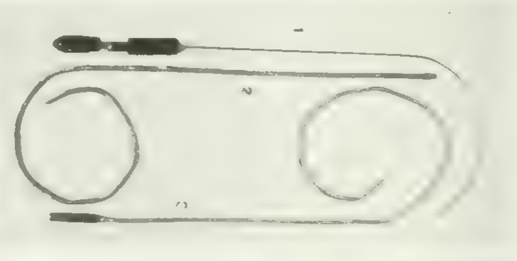


Fig. 5. No. 1. Wire stem and hard rubber tip with walls 2 mm. thick, into which the Universal tube applicator fits, with or without the extra brass filter. No. 2. A stem made of solder wire measuring 3.5 mm. in diameter and 40 cm. in length. The screw adapter at one end fits the applicator shown in Figure 4, No. 2. No. 3. A stem of solder wire. A brass shell is fixed at one end devised to fit the Universal tube applicator, and a Para rubber tube extends 5 to 8 mm. beyond the end of the tube.

finger cannot be placed in the rectal canal at the same time.

The length of the part (Fig. 4, No. 5) may vary to suit the tumor, but if it is 6 cm. long, it is convenient, since it can be moved along the surface of the tumor. A strip of adhesive plaster is placed around the rubber part and then fixed to the stem; this makes a rigid applicator. The rubber filter (Fig. 4, No. 3) fits the window and is intended to absorb the soft secondary rays from the metal tubes. A finger cot placed over the end and fixed with adhesive tape completes the instrument. This applicator is very easily tolerated by the patient. It can be accurately placed with the index finger and securely fixed to the body surface. It is suitable in the treatment of small bulky growths and tabular growths which do not completely encircle the bowel.

The applicator shown in Figure 6 holds two Universal tubes. Friction holds the cap in place, and a finger cot covers the whole. Similar applicators have been in use for three years and have proved to be very satisfactory. Its chief use is in vaginal applications. It is placed with the patient in the knee-chest position and the distended vagina is packed with gauze; thus a minimum of normal tissues is radiated. It can be placed in a wide open wound of a posterior resection and held there with packing.

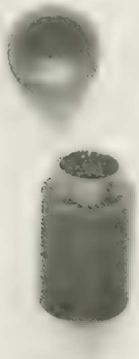


Fig. 6. A vaginal applicator which accommodates two Universal tubes. The brass wall is 1 mm. thick and is surrounded by 2 mm. of hard rubber. The outside diameter is 17 mm. and the length 4 cm.

In the treatment of inguinal glandular enlargements, a wood block (balsa) 2.5 cm. thick and 3 by 4 cm. at the base is used to maintain the distance. Two millimeters of lead and 2 mm. of Para rubber are employed as filters. Fifty or 100 mgm. of radium in a Universal tube applicator is fixed to the block and allowed to remain twenty and ten hours respectively. The skin surface is mapped out in areas 3 by 4 cm. and from 3 to 6 areas are exposed in each inguinal region.

Radium can be buried in the tumor or ulcerated area. The standard metal needles, with walls 0.4 mm. thick, may be used, or bare glass tubes containing radium emanation taken from a Duane series of mercury pumps. An instrument is being perfected to facilitate the placing of the steel needles by direct and indirect methods. They may be placed by direct vision through a proctoscope or by the use of a brass cannula of sufficient size. The method of choice is by bare glass tubes.

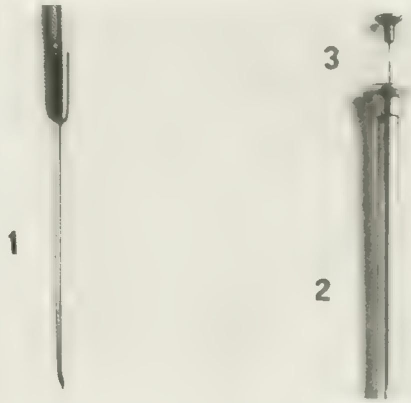


Fig. 7. No. 1. A spinal puncture needle, the end of which has been milled to fit the tube. No. 2. A brass tube made in various lengths, 20 to 40 cm. No. 3. A wire trocar long enough to dislodge the glass tube.

Figure 7 shows the instrument employed in the bare glass tube technique; it consists of a needle (Fig. 7, No. 1), a brass tube (Fig. 7, No. 2) and a wire trocar (Fig. 7, No. 3) of sufficient length to dislodge the bare glass tube. If the needle and tube are made to be interchangeable, needles can be kept sharp, which is very important.

In burying the radium, general or local anesthesia is required. If the needles are few in number and the mass small, the treatment is preceded thirty minutes by a hypodermic injection of $\frac{1}{300}$ gr. of scopolamin and $\frac{1}{6}$ gr. of morphin sulphate. Other anesthetic is not necessary. A general anesthetic is seldom used.

If our observations from treating the inoperable growths are correct, the operable growths should be exposed to radium, and after sufficient time has elapsed, probably six or eight weeks, the tumor area should be removed.

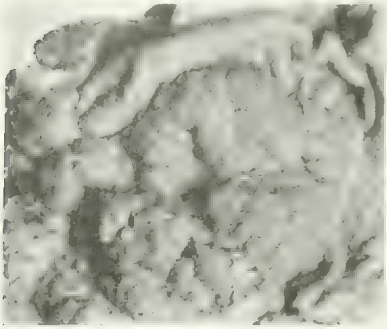


Fig. 8. (Case A100372). Specimen removed at operation.

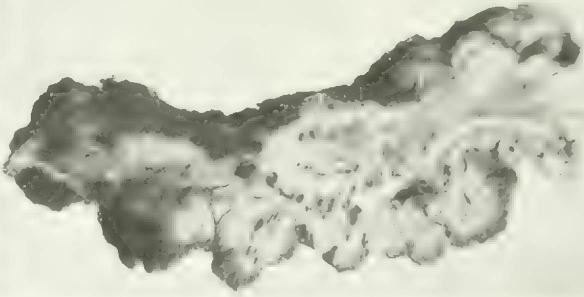


Fig. 9. (Case A100372). Longitudinal section of specimen shown in Figure 8.

"Surgical judgment" is not acquired in a few months, and may not be acquired for years; this is also true of radium therapy. The problems of the radium therapist are many. The patient, as well as the disease, must receive consideration. Should the patient's health be greatly undermined on account of the disease or weakness following surgical procedure, the treatment is usually reduced in the number of applications. Each group furnishes its own problems.

Figures 8 to 11 show good examples of the lesions encountered in this group. The mass (Figs. 8 and 9) protruded into the lumen of the rectum, causing partial obstruction. It would be possible to bury radium needles in this bulky tumor.

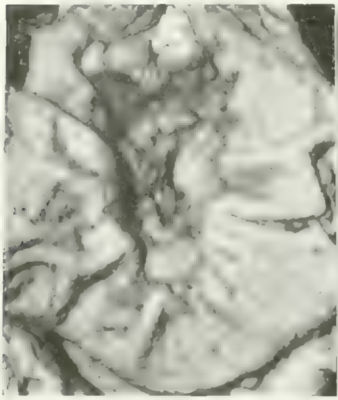


Fig. 10. (Case A170796). Specimen removed at operation; partial involvement of the walls of the rectum.

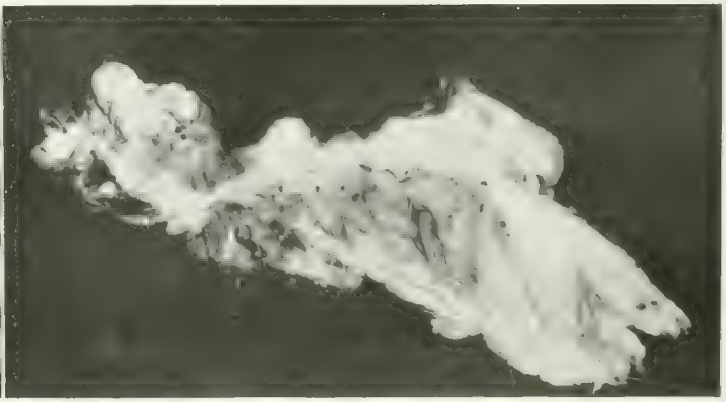


Fig. 11. (Case A170796). Cross-section of specimen shown in Figure 10.

The various types of tumors occurring in Group 1 require the widest range in technique. All buried radium treatment should be preceded by surface treatment. The extent is measured, and if it is within 4 to 7 cm., three treatments are outlined and recorded as high, middle, and low positions. The applicator used may be the one in Figure 4, No. 6, or, in Figure 5, Nos. 2 or 3. Fifty milligrams radium is allowed to remain in each position for fourteen hours at one or two day intervals. If growths are small, brass filters should be used; otherwise, they are omitted. The majority of the 22 patients were operated on within ten and fourteen days after the first treatment. Definite gross changes in the tumor and edema in the tissues were noted, and the incidence of infection was suspected to be rather high. In order to manage the patients in this group more satisfactorily, more time (at least four to six weeks) should elapse, after the first treatment and before operation. This interval is essential in order that the treated area may heal and the tumor tissue be replaced by fibrous tissue. All overradiation should be avoided. These cases require keen judgment and close cooperation between surgeon and radiologist.

If bare glass tubes are placed, the technique of Janeway is used. Tubes measuring 0.5 mc. are preferred. If the tumor is thoroughly radiated in this way, the results will be more certain.

In the inoperable group, Group II, the number of applicators is usually limited; the one of choice is that shown in Figure 5, No. 3. The canal through the tumor area is usually small and tortuous. The number of levels treated depends on the extent of the growth. Extensions in the region of the rectosigmoid area are the most tedious to expose, and these are usually undertreated. Three to four areas are the rule and are designated as high, middle, and low positions for application. Fifty milligrams is usually applied for fourteen hours in each area. A colostomy is not essential for this treatment, if, by abdominal exploration, the borderline case is found to be inoperable, and without obstruction. In some cases, the treatment will reduce activity and avoid impending obstruction. In this manner, the patient may get on without a distressing colostomy; however, an early colostomy is paramount in case obstruction develops. The most striking cases in this group are the ones made operable by radium treatments. Early metastasis is not a characteristic of cancer of the rectum, and if reduction in the tumor occurs, posterior resection should be performed. The time interval should be six to eight weeks. All the patients in our series were thus treated. In cases reported in the literature, longer applications were made and more radium was applied. Our policy has been more conservative, and our local reactions are less. If the radium applicator can be placed in the center of a bulky growth, more radium and longer application are indicated. Overradiation should always be avoided, and possible surgical difficulties prevented.

Group 3, the recurring group, should continue to grow smaller. All patients operated on, and particularly those not previously treated, should receive postoperative radium and roentgen-ray therapy.

The applicator shown in Figure 5, No. 1, and the vaginal package (Fig. 6) are best suited to cases in Group 3. Brass filters are essential in the absence of the tumor, which is usually made use of to absorb the soft primary and secondary rays. Fifty or 100 mgm. tubes are used. The number of applications depends on the size of the cavity to be radiated. Three to five is the rule. The time is usually ten to fourteen hours. The vaginal package is fixed to a cord which aids in the removal, and is held in the Kraske wound with gauze packs. The interval between applications is two or three days.

All patients should be under observation. The treatments may be given at intervals of six and eight weeks, for the first six to eight months after operation. Every possible aid should be employed to establish a diagnosis of recurrence on account of a possible inflammatory process.

The primary growth in the rectum is but slightly affected by the roentgen ray. Even the newer apparatus, with voltages of 200,000 or more, gives disappointing results, and so we must look to radium for destruction of the primary lesion. On the other hand, metastatic nodules and lymphatic tissues are more susceptible to the roentgen ray.

The object of the roentgen-ray treatment is (1) to destroy or decrease in amount the lymphatic tissue and thus decrease opportunity for metastasis, (2) to destroy or inhibit the growth of metastatic nodules.

The cases reported in this group were treated by the old technique, which consisted of a 23 cm. skin-target distance, filters of 3 or 4 mm. of aluminum, a spark-gap of 23 to 24 cm. between blunt points, and a current of 5 ma. sent through a broad focus standard Coolidge tube for five or six minutes. This formula produces a transient erythema in the skin, and at times causes slight pigmentation.

The rays were directed to the pelvis through 9 portals of entry, namely, 4 anterior, 4 posterior, and the perineum. This method produced a somewhat effective cross-fire for the deep glands, and radiated the superficial glands, such as the inguinal and the perineal groups. If these superficial lymphatic glands were definitely involved, they were treated with radium.

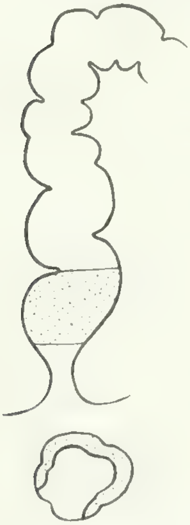


Fig. 12. A simple rubber stamp for the recording of accurate data. The dotted portion shows the extent of the involvement, height of lesion and rectal walls involved.

In the technique now employed, advantage is taken of the fact that a long skin-target distance assures nearly even distribution of radiant energy in the superficial tissues, and a large quantity of energy available for absorption in the deeper tissues. Nearly homogeneous radiation of short wavelengths is obtained by copper filtration and higher voltages.

The general reactions which usually follow the surface applications of radium and roentgen rays are similar to those seen in the treatment of other conditions. They are, as a rule, a mild degree of anorexia, nausea, vomiting, and weakness. This lasts for twenty-four to forty-eight hours, and gradually disappears. The local reaction is tedious to evaluate. Some patients complain of an increase in mucous discharge, with or without blood, and very little, if any, increase in pain. Urgency, frequency, and painful urination are seldom complained of. Proctitis rarely occurs. The technique, as described here, is very conservative, and severe local and general reactions are rare. In the buried technique, general and local reactions remain the same, although, on account of the impossibility of maintaining a sterile technique, infections occur. Ordinary cleanliness, enemas, irrigations, etc., are the only method, of preparing the field for the introduction of the needles. Fever of 102 to 104° F. has occurred, with the other usual signs and symptoms of general toxemia. Local peritonitis has occurred. The local complication may be hemorrhage and perineal abscesses. Mild hemorrhage is expected, and if severe, the rectum is packed with vaselin gauze through a proctoscope from the rectal side and if bleeding is from the distal colostomy loop, a long proctoscope, small in diameter, is placed in the loop and fair exposure is usually obtained. Vaselin packing may be introduced in a similar way as from below. The packing is removed in forty-eight to seventy-two hours. The patient is supported with the ordinary methods to control hemorrhage.

It is essential that accurate records should be kept. Figure 12 shows the possibility of a simple rubber stamp. It is self-explanatory.

SUMMARY

1. Radium, if properly applied, causes a definite inhibitory and destructive effect in the majority of neoplasms of the rectum.

2. Sufficient evidence is available to prove that radium is a valuable adjunct when added to our present surgical measures in the treatment of cancer of the rectum. The closest cooperation between surgeon and radiologist is essential.

3. In order to give the best possible individual treatment and to avoid discredit of either surgery alone or surgery and radium and roentgen-ray, an abdominal exploration should be made, except in gross inoperable cases.

4. Following exploration which determines inoperability with little or no low obstruction, it is not essential to make a colostomy in order to give the radium and

roentgen-ray treatment as outlined. Observation at intervals of from six to eight weeks is essential for the purpose of determining the advisability of radical operation.

5. The majority of patients with gross inoperable lesions should be given the benefit of radium and roentgen-ray therapy. A colostomy should be made at the first sign of impending obstruction.

6. The majority of patients receive inadequate treatment. It is impossible to give intensive treatment to some patients because of their general condition and because the entire tumor cannot be exposed. In patients with a colostomy, the growth should be treated through the distal loop. If the mass can be palpated by digital examination of the vagina, this cavity should be packed with radium in close proximity to the rectal tumor.

7. Early diagnosis is paramount. A digital examination should be made routinely of all patients. An early proctoscopic examination by an inexperienced physician is better than a late examination by a proficient proctologist. Microscopic examination is of definite value in early cases and will help to classify the cases, as well as to furnish a basis for prognosis when patients are operated on.

8. Some neoplasms of the rectum respond readily, while others are resistant to radium and roentgen rays. Long survival is possible in untreated cancer of the rectum. Our conclusions must be guarded until a large series of cases is available and sufficient time has elapsed.

9. Since radium in larger quantities and high voltage roentgen-ray equipment are at present available, a combination of these is the most ideal method for radiation therapy, and results should be better.

BIBLIOGRAPHY

1. Da Costa, J. C. Quoted by Cameron and Viol. *Radium,* 1921, xviii, 24.
2. Pinch, A. E. H. A Report of the Work Carried Out at the Radium Institute from January 1, 1921, to December 31, 1921. London, 1922, pp. 7 and 8.
3. Levine, I. The relative value of surgery, radium and roentgen rays in cancer therapy. *Urol. & Cutan. Rev.,* 1922, xxvi, 5–10.
4. McVay, J. R. Thesis—The Lymph Glandular Involvement in Carcinoma of the Rectum. May, 1920.
5. Labat, Gaston L. Latest achievements of the art of local, regional and spinal anesthesia. *Ann. Surg.,* 1921, lxxiv, 673–683.
6. Scholl, Albert J., Jr. Sacral anesthesia in urology. *J. Urol.,* 1921, vi, 149–167.
7. Symonds, C. J. Cancer of rectum; excision after application of radium. *Proc. Roy. Soc. Med.,* 1913–1914, vii, Clin. Sect., 152.
8. Durand, M. Cancer du rectum extirpé deux mois apres application du radium. *Lyon Chirurg.,* 1919, xvi, 408–409.
9. Handley, W. S. Case of inoperable carcinoma of the rectum becoming operable under radium treatment. *Proc. Roy. Soc. Med.,* 1915, viii, Surg. Sect., 3–8.

POSSIBLE DANGERS IN CONNECTION WITH THE USE OF X-RAYS AND HOW TO AVOID THEM

BY JOHN S. SHEARER, PH.D.*

ELECTRIC shock is due to an electric current passing through a portion of the body. The seriousness of such shock to the individual will depend on the part of the body traversed by the current, on its amount and duration and on the physical condition of the individual.

Data with reference to the amount and duration of current that would give a dangerous shock is somewhat limited, but it is certain that a small fraction of an ampere may be fatal if maintained for even a brief period.

In order to pass an electric current through the body, *two* areas of contact must be established between two points on an electric circuit that are maintained in different electrical states. We indicate this difference in condition by saying that they are at different voltages, or that a certain voltage exists between them.

The current passed will *increase* with the voltage difference and decrease with the resistance of the portion of the body included between the contacts. The resistance of the body may be as low as a few thousand ohms, and is very much less when the skin is moist than when it is dry.

Deaths due to circuits where the voltage between contact areas is less than 500 volts are rare, but they have been reported on as low as 80 volts; so that any voltage capable of operating an *x*-ray tube is well above any lower danger limit, and offers opportunity for fatalities.

In order to maintain an electric current, one must provide a means of maintaining voltage, as a flow of current invariably tends to reduce voltage. Thus, one may charge a small Leyden jar to several thousand volts and pass its discharge through the body without injury, as there is only a *momentary* current and the voltage lost is not replaced by a generator. On a large battery of such jars, this brief current might be so large as to cause serious injury or death.

We are mainly concerned with high voltages between conductors where current is supplied by generators wholly or in part maintaining the voltage. Any such circuit is potentially dangerous, and to a degree depending on the maintained voltage.

Since such circuits must be used, we depend on insulation or on insulators to prevent a conducting contact with the body.

An insulator is a piece of material that will prevent the passage of an appreciable current when two points thereon are maintained at a given voltage difference. There are no perfect insulators, and we consider insulating power as ability to prevent the passage of any appreciable current at the highest voltage to which the insulator is likely to be subjected. Thus if one applies 1,000 volts to an insulator having a resistance of 10,000,000 ohms, only one ten-thousandth of an ampere will pass. Insulators often rupture under high voltage, and also in many cases acquire surface conductivity. Thus, glass, when clean and dry, is a fairly good insulator, but when a layer of moisture (especially when this is slightly acid) is present, its insulating power is greatly reduced. Insulation must be designed and used with reference to the voltage to which it is to be subjected. Thus, complete insulation for 500 volts may be of little service for 15,000 volts.

Electric shock is due to *flow* or movement of charge, *not* to its presence. One may become charged to a high electric voltage and be quite unconscious of the fact, if the charging is done *slowly;* also, a *slow* discharge will give no sensation. In order to have a continuous flow of current through the body, we must have two points of contact with more or less conducting bodies between which there is maintained a tendency to drive electricity, i.e., a voltage.

The maintenance of voltage is due to generators of various types, and those voltages high enough to be dangerous are usually secured by transformers in cases where *x*-ray tubes are operated.

---

* Professor Shearer died May 16, 1922.

As a general rule, our bodies are in more or less conducting connection with the earth, which, due to moisture and large size, is a fairly good conductor. Also, generators and transformers are often connected at one point to earth, or "grounded," and, in general, are only insulated at other points for voltages somewhat in excess of their maximum operating voltage. Contact by the body with a non-earthed point on the circuit will offer the current a choice of paths between the contact point and the grounded point, either through the body or along the usual path. Some current will take the former path, and it remains to consider when danger arises.

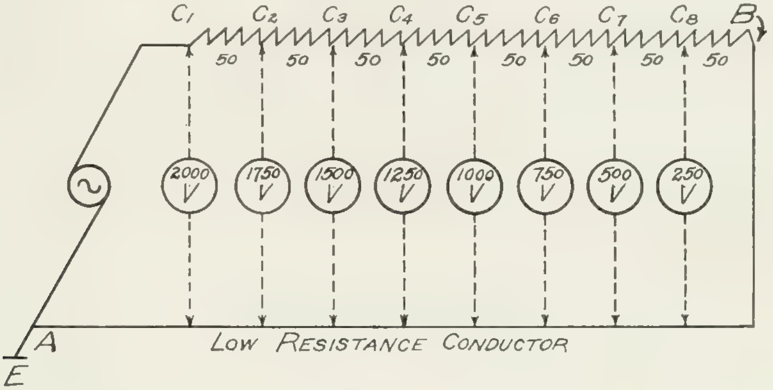


Fig. 1.

Let us assume that a maintained difference of potential of 200 volts between two points on the body is dangerous, and see under what conditions we may have such a voltage. A higher voltage might have been chosen, but the principle is the same.

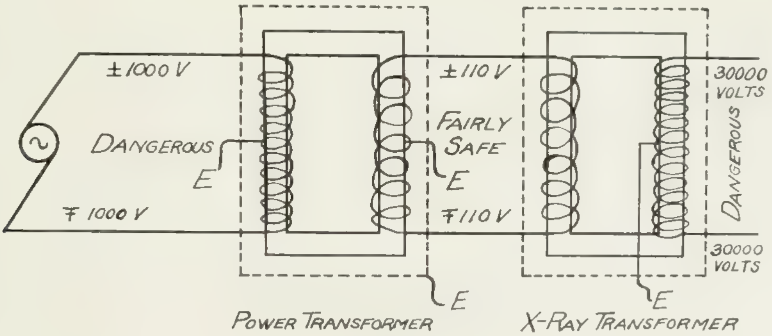


Fig. 2.

Consider a generator that maintains a voltage of 2,000 volts between its terminals when supplying current to a line of 400 ohms' resistance, one terminal of the generator being grounded (Fig. 1).

The large conductor AB shown is at no voltage above the earth. C_1 is 2,000 volts above or below earth, and C_2 is 250 lower than C_1, or 1,750 above earth. A person having connection with the earth and touching C_7 would have one point of his body at 500 volts above another, and might be injured. He could probably touch a point between C_8 and B with safety. If insulated, he could safely touch any one point between C_1 and B, but must not touch two at once, between which a dangerous voltage exists, as say C_4 and C_7.

Generators furnishing AC current at voltages above 500 volts are not wired directly to house lines, but to transformers that "step down" the voltage. This is again "stepped up" for *x*-ray operation.

Figure 2 shows such a line and regions of danger where a grounded middle is used.

No part of the 2,000 volt line is safe for a person grounded, except the middle of the primary, which may be safe if connected to the case or earthed. Any part of the line between the two transformers is reasonably safe. None of the *x*-ray secondary except its middle point can be regarded as free from danger.

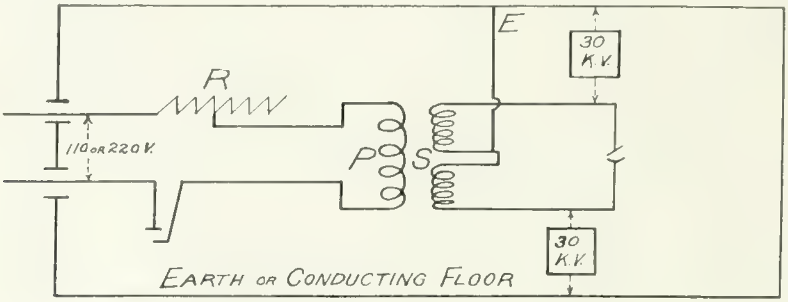


Fig. 3.

Most *x*-ray transformers have their secondaries wound in two, four, or more sections and the middle of the system connected to the metal transformer case. This may be earthed, or simply stand on a more or less conducting floor. In either case, when one comes in contact with the high tension line, there is an opportunity for current to pass through the body to the floor, and thence to the middle of the secondary. The amount of this current for a given line voltage will vary greatly with the resistance of the support on which the person is standing. If the floor is highly insulating, the current will be too small to be troublesome; otherwise it may be very dangerous, or even fatal. Concrete and tile floors are fair conductors, especially when moist. Wood floors may have nails reaching or near conducting material. Figure 3 shows the circuits in this case.

On contact with the line, one-half of the transformer secondary becomes effective driving current from the outer terminal through the body to earth and back to the middle point of the secondary.

When one secondary terminal of the transformer is grounded instead of the mid-point, all parts of the line between that terminal and the tube will be safe to touch so long as the ground is maintained. However, for the same operating potential the ungrounded terminal will be twice as dangerous, or at least would pass twice the current over the same resistance as before, and would be twice as likely to spark over.

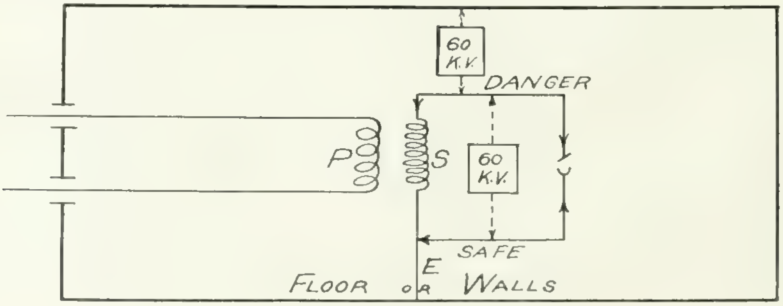


Fig. 4.

This construction is frequently used with the right-angled dental tubes operating on rather low voltage. It then renders the terminal nearest the patient safe, and makes proper separation from the other line imperative. This construction should not be used for ordinary 5-in. gap outfits.

Clearly, the only entirely safe procedure is either to insulate completely *all* parts of the high tension circuit, as when transformer, line and tube are all immersed in oil, or to insulate operators and patients so that contact between points of dangerous voltages is impossible. Probably neither of these can be fully carried out for all work at present, but much can be accomplished to reduce danger, even in old installations.

Nature of Accidents Reported. A survey of reported accidents may be classified as follows:

1. Accidental closure of low tension switch.
2. Short circuit of foot switch or locking in position.
3. Leaving low tension switch closed and attempting to adjust tube or reels.
4. Coolidge filament wires hanging too low.
5. Breaking of reel wire and the end attached to the tube falling on the patient.
6. Attempting to set a double scale milliammeter when operating switch is closed.
7. Failure of high tension insulators.
8. Crossing of high and low tension lines.
9. Failure of insulation of low tension circuit.
10. Bringing the tube too close to the patient.
11. Leaving wires too close to the patient.
12. Spark-over due to surge.
13. Failure to shift high tension switch to proper side before closing primary.
14. Breaking of overhead line.
15. Attempting to measure spark-gap with a ruler when power is on.
16. Discharge to diaphragm control due to slack reel wire.
17. Break in primary insulation cutting out part of the control and thus causing unusually high voltage.
18. Unusual spark-over due to failure to close filament circuit on a resistance controlled machine.
19. Contact with unused connectors or reels, sometimes in rooms where one has no information as to whether high tension is on or not, viz., fluoroscopic room separate from the radiographic, and operated by a transformer in the latter—a dangerous practice.

Of these various accidents, all were painful and some were fatal. While those enumerated do not exhaust the possibilities, yet if their chance of occurrence were minimized we should have accomplished considerable toward making outfits electrically safe.

1. Would not occur if it were necessary to perform two *voluntary* acts each time an exposure is made and *all* switches were self-opening. Thus a latch device that has to be held out before a switch can be closed, and a spring opening the switch when the hand is removed would make closure deliberate in all cases. Push-button switches should have a stop making pressure at two points necessary for operation.

2. No foot switches should lock closed, or have such weak springs as will permit a slight pressure to close them. All breaks should give a clearance large enough to avoid possibility of arc or accidental bridging.

3. Would not happen if the suggestions in No. 1 were adopted and the operator was obliged to stand where there is a full view of the tube, patient and high tension line. Lead glass windows, if used, should be large enough to permit such a complete view.

4. If overhead tubing is used, Coolidge wires should be drawn inside of one tube and reels should be firmly supported.

5. The flimsy reel wire, often only tinsel, so commonly used, is inexcusable. A braided tube over a twisted center made up of very fine *enameled* copper wire is at once strong and flexible.

6. No double scale milliammeters should be permitted. For treatment a 0 to 10, for radiography a 0 to 100 scale covers all needs. This would avoid danger of changing during operation and of treating with an improper scale setting.

7. A noteworthy example of this was seen where a hard rubber insulator passed through a lead box on a vertical fluoroscope. The fluoroscope was mounted on wooden castors. The lead was left sharp edged around the rubber and by corona

action finally broke through. The discharge passed from the lead box to the metal diaphragm handle to the observer and thence to the floor. Micanite tubes, or hard rubber tubes with a thin inside metal tube would prevent such an accident.

8. This means improper installation or loose wires hanging where contact is possible.

9. A switch opening only one side of the power line was opened under conditions giving a heavy surge. This broke through the primary insulation in such a way as to leave a small primary current still passing. All circuit breakers and switches should break both lines, i.e., be of the double pole type.

10. No arrangement of ordinary apparatus will protect a patient from a careless operator.

11. Same as 10; reels should always keep wires taut.

12. This may exceed ordinary operating or spark-gap voltage.

13. Only one connection should be possible at one time and the operator should be able to close the circuit only when in a given position.

14. Poor construction to be avoided.

15. A careless procedure. A well insulated handle and a proper scale should be provided.

16. Poor reels, or worn covering. See reel wire above.

17. May give a much greater voltage than intended.

18. On large machines the Coolidge filament should light when the motor switch is closed.

In cases 1, 2, 3, 13 and 14 there is a chance of a person's coming in contact with both high tension lines, and it is immaterial whether or not he is insulated. In all cases where contact would be at one point only, an insulating floor would be a great safeguard.

Special attention should be given to portable, bedside and dental machines, where the high tension lines are, or may be, dangerously close to operator or patient. It must not be assumed that low power transformers are safe; they may, as stated above, be especially dangerous. The facts that these outfits are of necessity so compact, must often be operated in very limited space or adjacent to other apparatus and in proximity to nurses, and often on bedridden patients, make it imperative to render them as safe as possible, and then to insist on great care in their operation.

Foot switches should never be used with these machines on account of the danger of their closure by accident while the tube is being adjusted. The high tension wires should run vertically upward at least to the level of the tube, and pass through insulating tubes of mica or hard rubber to a height several inches above the level of a bed. All the high tension wires should be as far away as possible and must be kept taut. They should have a quick acting circuit breaker set as close to the normal operating current as possible. Switches should be self-opening and should require two movements for their closure.

The practice of making dental radiographs in the usual metal dental chair is a constant source of danger. Such work should be done in wooden chairs that are well insulated.

Considerable discussion has arisen in connection with grounding parts of *x*-ray installations, and there seems to be an idea prevalent that if only grounds enough are provided, all else may be neglected. This doubtless arose, in part, on account of the grounding of conduits, transformer cases, motor frames, etc., in wiring practice. If one could never touch any *ungrounded* portion of the circuit, safety would be certain, but if one does touch a high tension line, then contact with a grounded floor or support is a *source* of danger. Note the number of cases where electrocution has resulted from contact with rather low tension circuits when a person was in a bath tub, standing on a wet cellar floor, or with wet shoes against a radiator. Here the victim was between a line above earth potential and the earth. A lineman does not ground himself, if he can avoid it, when he repairs a moderate, much less a high voltage line; rather he wears insulating gloves. Also good wiring rules do not permit placing a metal lamp socket in a cellar or near enough to a bathtub to be reached by the occupant. Porcelain sockets with porcelain-covered keys are used in such places. Grounding never secures as complete immunity from danger as does complete insulation. No one denies the desirability of grounding certain things, but we must not delude ourselves that no discrimination is needed, for the improper use of grounded conducting material may increase rather than decrease danger.

Testing. A few simple tests may assist in determining whether installations are reasonably safe or not:

1. What regions are in danger of spark-over to operator or patient? Place a metal plate or water in a metal pail on the floor. Insulate a milliammeter and connect one terminal to the plate or the water, fasten a piece of flexible wire to a dry stick about three or four feet long and approach it to various parts of the apparatus when in operation. The spark distance and the milliampere reading will give a fairly good idea of the danger if the body replaced the wire.
2. Test overhead systems by hanging a weight on the middle portion considerably in excess of the pull of the reels when fully extended.
3. Milliammeters in series should give identical readings. This test is easily made.

Line leakage in therapy can be tested by putting one milliammeter close to the tube and the other close to the transformer. When a meter near the transformer reads 5 ma., and .5 ma. less near the tube, the error is considerable. Leakage is always greater at higher voltages.

THE AMERICAN JOURNAL OF ROENTGENOLOGY
AND RADIUM THERAPY
Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

REPORT OF THE SAFETY COMMITTEE PRESENTED AT THE LOS ANGELES MEETING OF THE A. R. R. S.

This report covers only one phase of the subject assigned to this Committee for study, namely, the danger from high tension shock. In formulating our report, we have thought it advisable to make the following recommendations. A preliminary discussion of the subject by the late Professor Shearer will be published in the Journal.

1. *X*-ray equipment should not be installed or operated in low-ceiling rooms with overhead piping, or in damp or poorly ventilated rooms.

2. Floors should be covered with cork or other insulating material.

3. Footswitches should not be used in any radiographic work.

4. All diagnostic operating switches should automatically and positively open when released.

5. Double scale milliammeters should be eliminated.

6. Two milliammeters in series should be used in treatment.

7. All *x*-ray apparatus should be equipped with quick acting circuit breakers, preferably of double pole type. These should open with certainty on a 20 per cent overload. Circuit breakers should be tested at least once a month and a permanent record kept of these tests. Properly rated fuses should be used in addition to circuit breakers.

8. Where overhead high tension lines are used they should be of metal tubing not less than ½ in. in diameter. They should be firmly mounted and extend to the transformer or rectifier terminals.

9. High tension reel wire should be of fine braided enameled copper without cloth covering, strong enough to stand a pull of not less than 50 lbs. weight.

10. High tension reels should be firmly mounted and have proper winding guides to prevent catching when winding, and sufficient tension to wind up against a pull of 1 lb. weight.

11. Vertical and horizontal fluoroscopes should be so enclosed by insulating materials as to prevent operator, patient or assistants from approaching within sparking distance of any part of the high tension system. Metal screens should not be used if the fluoroscope table permits the use of a tube *over* the patient.

12. In every installation the operating switch should be so placed that a full and unobstructed view is had of the high tension line to be used. If lead glass windows are provided, they should be large enough to insure such a view.

13. All tables used for treatment with the patient between the tube and the table should be made of insulating material, unless the tube and terminals are enclosed in a permanent grounded case. No spring mattresses should be allowed.

14. Tables used for radiographic and fluoroscopic work should be of insulating material when practical, and the handles of all switches and diaphragm controls should be of such material.

15. Where tubes in more than one room or booth are to be operated from the same transformer, provision should be made so as to make impossible simultaneous operation or closure by anyone not in direct

charge of the tube or line used. This may readily be accomplished by suitable interlocking switches or otherwise.

16. All bedside or portable outfits should have their high tension lines so placed that they permit of doing bedside work without having their wires come nearer to the patient than the tube terminals.

17. No treatment apparatus should permit any part of the high tension system to come closer to the patient than double the operating spark-gap, unless protected by a suitable insulator.

18. *Permanently* placed grounded metal screens between the tube and the patient are permissible and advised where the spark-gap exceeds 10 in.

19. Machines for high voltage therapy should be so designed that their milliamperage on a short arch discharge is not more than 50 ma.

In conclusion, the Committee recommends that in view of the constant and rapid changes taking place both in the application of *x*-ray and in the manufacture of apparatus, a Board be appointed to which questions having to do with the dangers incident to the use of radiation of short wave-lengths and the apparatus used to produce them, can be referred. It has seemed to this Committee that this subject is too large and is changing too rapidly to be covered in any one report, and that it would be better to take up individual problems as they arise.

Respectfully submitted,
G. W. Holmes, Chairman.
P. M. Hickey,
W. D. Coolidge,
H. K. Pancoast.

THE DOCTOR SOFIE A. NORDHOFF-JUNG CANCER RESEARCH PRIZE

Dr. Sofie A. Nordhoff-Jung of Washington, D. C., U. S. A., has founded an annual prize of five hundred dollars bearing the title, "The Sofie A. Nordhoff-Jung Cancer Research Prize." This prize is destined for the encouragement of researches in the etiology, prevention and treatment of cancer. It will be awarded by a commission composed of members of the University of Munich, Bavaria, and be granted for the first time in December of the year 1923. The commission consists of Professors Borst, Doederlein and Sauerbruch, with Professor von Romberg as chairman. This body is empowered to elect successors. The award will be made as a recognition of the most conspicuous work in the world literature bearing on cancer research, done at a time antecedent to the allotment of the award. Though the prize will not be awarded on a competitive basis, the commission invites all research workers in cancer to submit literature on this subject.

A COMPLETE EXAMINATION OF THE CHEST

Does practice make perfect? In relation to the clinical examination of the chest, we certainly hesitate to assert that it does. It is a frequent experience, in certain types of cases, to doubt one's sense of hearing and touch. There comes a time in every honest clinician's experience when varying and not necessarily complex changes in the lungs puzzle, confound and discourage him. The simplest cases are frequently the most difficult to interpret, and often after failing to diagnose correctly through the sense of touch and hearing, a period of discouragement ensues.

Specialists in chest diseases have as yet failed to see the enormous value of fluoroscopic and radiographic examination. They have, to a large extent, failed to combine the sense of sight with the other two senses, and in consequence, have lost a tremendous moral support. The proper use of radioscopy does not conflict with or contradict other physical results. It is a constant education, and it increases the usefulness of the physician's hands and ears as well as his self-reliance. Unhappily, in the past, ignorance and prejudice have hurt both the chest specialist and the radiographer. The matter needs readjustment, that greater use may be made of the advantages of *x*-rays.

The function of the lungs depends upon changes within the thorax, and frequently, although a correct diagnosis of the disease is made, the actual functional changes are not understood. Fluoroscopic examination to determine function is not so difficult to carry out and is a remarkably exact method. Without it, is a clinical chest examination, from the patient's point of view, complete? As a matter of record and for future study and comparison, the examination should include a fluoroscopic and radiographic examination. When the clinician becomes expert in this method a good deal of prejudice will fall by the roadside. In that day the saying, "Practice makes perfect," will be more truthfully applied to the examination of chest diseases.

James A. Honeij.

AMERICAN RADIUM SOCIETY

Eighth Annual Meeting

The American Radium Society will hold its eighth annual meeting at the Civic Auditorium, San Francisco, Calif., on Monday, June 25, and Tuesday, June 26, 1923. A program of unusual interest and merit will be provided and it is to be hoped that all interested in this virile subject will make a special effort to attend. The American Medical Association is holding its meeting at San Francisco this year, and thus it will be possible for one to attend the meetings of the two societies. The headquarters of the Radium Society will be the Hotel Whitcomb. This is the first time that the American Radium Society is holding its meeting on the coast, and it is worth remembering that there are things medical in that section of the country which are well worth seeing. Besides, there are atmosphere, scenery and other things.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page iii of this number of the Journal. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Stokes, John H., and Brown, Philip W. Two Hundred Syphilitic Patients Whose Chief Complaint was "Stomach Trouble": An Interpretative Analysis of the Diagnosis of Syphilis in Consultant Medical Practice. *Am. J. M. Sc.*, Dec., 1922, clxiv, No. 6, 867.

In the course of this article, the authors give some extremely interesting statistical data concerning gastrointestinal symptoms in cases of syphilis. In a series of 200 patients, there were 35 on whom needless operations had been performed, because of various aspects of syphilis leading to the complaints of stomach trouble. On the other hand, there is a group of patients who present a problem in which the surgeon should have the right of way over the syphilographer. The authors recommend that when, after a very careful study, the question of malignancy is raised in the face of a concomitant syphilis, the most important move is the surgical exploration, which will clinch the diagnosis and afford the patient the promptest and best prospect of relief. On the other hand, patients with inoperable, or presumably inoperable, abdominal malignant lesions, from whom a suspicion of syphilitic infection can be obtained, should be given the benefit of treatment for syphilis. In the list of 200 syphilitic patients studied, test meals were given in 122 cases and roentgenological study made in 131. The roentgen examinations were negative in 110, 11 had duodenal ulcer, 1, gastric ulcer, 1, cardiospasm, 4, gastric syphilis, and 4, questionable pyloric lesions. The authors have observed striking symptomatic improvement in certain cases of gastric and duodenal ulcer in neurosyphilitic patients in whom the roentgen ray after treatment showed the lesion itself to be still present.

Platt, Harry. Pseudo-Coxalgia: A Clinical and Radiographic Study. *Brit. J. Surg.*, Jan., 1922, ix, No. 35, 366.

The author, in conjunction with his radiological colleagues, Dr. J. M. W. Morison and Dr. A. E. Barclay, here presents an extensive study of pseudo-coxalgia. This disease, otherwise known as osteochondritis deformans juvenilis coxae, is a definite entity representing the reaction of the metaphyseal region of the upper end of the femur to the stimulus of an infective agent of attenuated virulence. The condition is comparable with the arthritis deformans juvenilis coxae which is seen solely in adolescents, and which represents at this age period the reaction of the hip-joint to an infective agent of a similar type. The whole cycle of radiographic changes is peculiar to pseudo-coxalgia alone. They precede and outlast the clinical phenomena. The final picture is dominated by the deformation of the head of the femur, which is enlarged and flattened. The acetabulum in its final form can no longer contain the whole of the expanded head. Deformation of the head of the femur with flattening and expansion is seen also in conditions distinct from pseudo-coxalgia during childhood. There is no evidence to show that in these conditions the typical structural osseous changes of pseudo-coxalgia have preceded the stage of flattening. At certain stages the clinical and radiographic pictures of the two groups of affections may show considerable resemblance. This applies particularly to cases of primary tuberculous osteomyelitis of the femoral neck. In the conditions known as tarsal scaphoiditis (Köhler's disease), and apophysitis of the tibial tubercle (Osgood-Schlatter's disease), bony changes parallel to those in pseudo-coxalgia are found. Conservative treatment directed toward the elimination of weight-bearing has no proved influence on the train of morbid changes, but its application is indicated during the stage of prominent symptoms. Operative treatment directed toward the removal of the dominant lesion has no present place in the therapeutics of this disease.

The article contains a very complete discussion of the radiological findings which should be referred to in the original by radiologists who wish to consult with authoritative work.

White, J. Renfrew. A Case of Multiple Pulsating Bone Tumors. *Brit. J. Surg.*, Jan., 1922, ix, No. 35, 458.

The author, after commenting upon the rarity of multiple pulsating tumors of bones, cites a case: Male, aged twenty-eight, suffering from painful swollen and stiff right knee, painful swollen right heel, varicose veins of right calf. Twelve months before, he had knocked his right knee with some violence against a counter. Ten months later he inflicted a further and more severe injury on the joint in a bicycle accident. Some three years earlier, the patient, while in military service, had some trouble with his right heel, which subsided; but eight months before the patient was seen (four months after the first accident to his knee) his heel again became tender and swollen. *X*-ray examination showed marked decalcification of all the bones of the foot, reaching a maximum in the os calcis, in which, indeed, actual cavity formation seemed indicated. The lower end of the femur showed a similar change, with signs of a recent pathological fracture of the condyles. A clinical diagnosis of tuberculous disease was made. The femoral condyles were found to be expanded, and at several places, perforated by a very soft vascular friable tumor which had invaded the muscle, and, in places, the knee-joint. The tibial tumor was of similar structure. The patient underwent several operations, the first for scraping away granulations and resecting the walls of the cavity. The wound healed by first intention. The leg was maintained in a plaster of Paris cast. On November 23rd, the patient returned, complaining of pain about the middle of the leg. The knee-joint was swollen and pulsating visibly, and a marked systolic bruit was to be heard, over the joint, with a stethoscope. In the middle of the leg over the front of the tibia was another pulsating, fluctuating tumor, and over this, too, a loud bruit was audible. Radiologically, there was seen a complete solution of continuity of the shaft of the tibia—a spontaneous fracture. A high amputation was therefore done. Examination of the amputated limb showed the femoral condyles excavated, expanded, and, at several places, perforated, by a very soft vascular friable tissue, which had invaded the adductor magnus muscle and, in places, the knee-joint. The tibial tumor was of a similar structure and appearance, and had destroyed and replaced 2 in. of the shaft of the bone, without, however, having perforated its periosteal sheath. An incision into the heel and remains of the os calcis showed but ordinary scar tissue, and nothing to suggest a recurrence of the tumor growth. The final diagnosis was a sarcomatous formation corresponding to an alveolar sarcoma.

Cherry, Thomas H. The Uses of Radium in Gynecology. *New York M. J. & Med. Rec.*, July 5, 1922, cxvi, 1.

This paper gives a brief outline of the uses of radium in gynecology. In the course of his remarks, the author states that all cases of uterine carcinoma are not fit subjects for radium therapy, any more than they are for surgery. When a large fungating carcinoma of the cervix with metastases is treated with radium, a tremendous amount of cell destruction takes place, with the consequent absorption of the products of cell disintegration. It is, therefore, necessary to ascertain if the organs of elimination can take care of this extra strain placed upon them. A thorough test should be made of the patient's general physical condition, including kidney function test, urinary findings, blood chemistry, hemoglobin and red cell count. If a patient with inoperable cancer, for example, has hemoglobin of 30 to 40, a 2,000,000 red cell count, and urine with albumin and casts, and with a phthalein output in two hours of 10 to 30 per cent, and blood chemistry showing carbon dioxide combining power of 25 to 40 per cent mgm. to 100 c.c. and a marked retention of urea nitrogen and creatinin, that patient is not a candidate for radium. First transfuse with whole or citrated blood, and then, if, after a time, the patient improves, radium therapy may be instituted.

Perthes, G. Radiotherapy of Malignant Tumors. *J. de radiol. et d'électrol.*, March, 1922. *Radium*, July, 1922.

The author reports "the present actual state of roentgen therapy" on "broad lines" and limits himself to "three questions of particular importance."

First. At this time what part do *x*-rays take in healing malignant tumors? To what extent can they be taken into account in fixing therapeutic indications? Of the cases formerly treated surgically, which ones should we now submit to roentgen therapy?

In the beginning, he discusses only cases of operable cancer, and considers, along with the successes of *x*-rays, those of radium, because in spite of "irrefutable theoretical considerations on the basis of which massive homogeneous irradiations with strongly filtered *x*-rays are preferable to the more narrowly localized action of radium, practical experience has shown that better therapeutic results are obtainable with the combined use of radium and *x*-rays."

The observation that *x*-ray can bring about healing of cancers of the lip and of the skin, first made by Magnus Moeller in 1898, has been confirmed many times. Likewise have such good results followed radium therapy, and though there are opinions to the contrary, the results obtained in the treatment of both the prickle-celled and the basal-celled epitheliomata are equally good.

From the esthetic side the result is often ideal, and so superior to surgery. The idea that there has been only a superficial healing must be abandoned, because results over long periods indicate the contrary.

If the results obtained were uniformly good, roentgen or radium therapy would always be the preferred method. However, such is not the case, as, occasionally, though there is disappearance of the principal tumor, a portion is left which later proves unresponsive to the action of the rays, even though the treatment which obtained the earlier good results is repeated. Here, occasionally, radium will give good results, but some growths are refractory to it. In cancer of the lip, the "cures" after three years are about the same (80 per cent) with either surgery or irradiation. In treatment of cancers of the lip and skin the author prefers irradiation, but warns that the patient be kept under careful observation. For cancer of the penis he prefers radium therapy, even more than for epitheliomata of the face and lip.

In cancer of the buccal mucosa and of the tongue, conditions are less favorable to both surgery and radiotherapy, and no cures have been observed with *x*-rays alone. Stricker reports, however, two cases of papillary cancer of the tongue cured four years after treatment with radium. The infiltrating type of lingual cancer is the least responsive, but combined with radium and deep roentgen therapy has given better results. Béclère has added to his translation Regaud's opinion that in view of the dangerous and mutilating results of surgical removal of the tongue, and the small number of cures, the continued investigations of radiotherapy are warranted here.

Though in cancer of the jaw some cases of healing by radium have been reported, the author believes that the improved surgical technique with its results is to be preferred.

In cancer of the larynx and pharynx, local healing may follow *x*-ray and radium therapy, but recurrences and metastases are frequent, and surgery must be resorted to.

Cancer of the esophagus is best treated by *x*-ray and radium, and though cures are not often the result, the relief to the patient warrants their use. In the stomach and intestine, surgery is still to be preferred. If some day radiotherapy is to be given preference, it will be first for cancers of the rectum. Of 5 cases treated in 1918, 3 have subsequently died, but two women were living and in good health about three years after treatment. The tenesmus passed away after a time.

Cancer of the breast can sometimes be cured by irradiation alone, one writer having reported 16.6 per cent and another 14.2 per cent of cures after three years, where no surgery was done. However, the surgical cure is better, and when the cancer is operable, surgery is to be preferred.

In treatment of cancers of the cervix uteri, combined *x*-ray and radium therapy is most often used, although remarkable results have been obtained by the use of *x*-rays and of radium alone. However, radiotherapeutic results have not surpassed the surgical, although many inoperable cases can be credited to radiotherapy. But most of the clinics claim best results in patients who have been rayed after operation, and in only carefully chosen cases, depending on the location, would this writer renounce surgery in favor of radiotherapy alone.

"Thus with the exception of cancer of the esophagus technically accessible to the knife but practically inoperable, we will send to radiotherapy only cancers of the skin, of the lip, and, under some conditions, but not always, cancers of the tongue; finally, cancers of the larynx above the vocal cords and perhaps with precaution, cancers of the rectum."

The greatest results from roentgen therapy have been in the inoperable cases, as in those of the breast. Cures are not often obtained, but the ameliorations are worth while.

There are, of course, exceptions to all cases, but the exceptions do not nullify the rule that even with the aid of radiotherapy the cure of inoperable cancers cannot be obtained.

Postoperative recurrences frequently respond to irradiation and sometimes remain "cured" for long periods, so that prophylactic raying after operation is generally indicated. However, Neher found more recurrences in those breast cases that had been rayed than in those that were not so treated.

As to roentgen therapy of sarcoma, he accepts Jungling's report to the Congress of German Naturalists reported in *Strahlentherapie*, vol. xii.

Lymphatic sarcomata react well to roentgen therapy as compared to surgery, and should be irradiated. Metastases and extensions are common.

Periosteal sarcoma at the hip-joints, shoulder region and pelvis should receive *x*-ray therapy.

Myelogenous giant-celled sarcomata should be irradiated at the time of operation, and radiotherapy should be tried before resorting to amputation.

Osteosarcomata of the skull have been cured over long periods by roentgen therapy.

Sarcomata of the superior maxilla should be treated surgically.

All inoperable sarcomata should be irradiated, even the gliosarcomata where roentgen therapy has done as much as palliative trephining.

In cases of tumors of the hypophysis, good results have been obtained, and also in tumors which, like them, are on the margin of neoplasms of good or bad nature: that is, the fibrous nasopharangeal tumors. These should not be operated on until deep roentgen therapy has been tried.

The successes which are reported would have seemed unbelievable twenty years ago, and in spite of the bad results, we must, as physicians, render homage to the progress, even though, as operators, we may deplore it.

We must not overlook the dangers of irradiation from the simplest reactions to the incurable roentgen cachexia. These are fortunately becoming fewer and fewer, but are still important. Also we must bear in mind the uncertainty of results, whether the technique or other things are responsible for them.

Second. Is the task of roentgen therapy solely to give to all parts of the body which harbor cancerous cells a determined dose for these cancerous cells? When we succeed, may we be certain of success? In other words, is there a cancer dose?

Essentially the question resolves itself into one of whether or not the cells of all cancers in all patients in all parts of the body, regardless of histological form, react in the same way to roentgen rays. Seitz and Wintz say: "We ought to refuse to admit a refractory state of sarcoma or carcinoma cells to roentgen rays." Against this we have seen superficial metastases disappear under light irradiation, whereas others in well-nourished patients would not regress though given the lethal irradiation for the skin. The author agrees with Jungling in saying that unfortunately there is no cancer dose, even omitting the cachetic patients. The difference between the radiosensibility of different sarcomata is even greater; for instance, lymphosarcomas respond to a small irradiation, whereas those of the melanotic group are very resistant, and moreover, tumors of the same histological structure frequently react quite differently to the same irradiation.

Work has been done on lower animals, demonstrating that different individuals react differently, and the same is unfortunately true of the various tumor cells. A sort of acquired "radio-immunity" must also be considered. We must take into account every biological condition in every cell, for the question of radiotherapy is not purely a physical problem.

Third. On what point do the *x*-rays exert their action? How may one represent the mechanisms of their action? To what practical deductions will this lead?

We know that *x*-rays act principally on tumor cells to damage them. This has been conclusively demonstrated in the study of sections of the tumor and its surrounding tissues. The nuclei of cells have been attacked during mitosis and without reference to disturbed surrounding blood supply. In other words, *x*-rays in sufficient quantities arrest growth. But this may not be all that takes place.

The selective action on certain types of cells has been conclusively demonstrated. However, if such action was all, we could give *enough* radiation to be sure that the growth would disappear. Unfortunately, they do not disappear with the heaviest doses, but may grow even more rapidly; possibly because the surrounding tissues had been so much damaged that they were unable to resist the tumor invasions. Hence we should try to damage the malignant cell, and not overdose its normal neighbor.

We must not forget the importance of the whole organism as well as the mutual actions of the normal and malignant tissues of the area affected, for possibly the purpose of roentgen therapy is only to increase the natural process of healing.

BAYNE-JONES, S. and VAN DER LINGEN. The Bactericidal Action of Ultraviolet Light. *Johns Hopkins Hosp. Bull.*, Jan., 1923, xxxiv, No. 383, 11–15.

This paper describes methods by which exact determinations may be made of the wave-lengths of light which kill bacteria. The sparks of various metals were used as sources of ultraviolet light, except in a few experiments when it was necessary to take advantage of sunlight because of its greater intensity. In most of the work a quartz spectrograph was used. The absorption spectrum of a bacterial emulsion was correlated with the limits of the bactericidal action of light. The effect of temperature and the influence of hydrogen-ion concentration upon the limits and velocity of the germicidal action of ultraviolet light were determined. From the results of these experiments the following conclusions are drawn:

1. The bactericidal action of light is confined to the ultraviolet region of the spectrum, beginning at 350_{uu}, and extending with increasing intensity to the shortest wave-lengths measurable with a quartz spectrograph: 185.6_{uu}.

2. These limits coincide with the absorption of ultraviolet light by bacteria.

3. The temperature coefficient for the bactericidal action of light was found to be 1.05 over a range of 10° C., and the constant u in the formula Arrhenius was 934 to 975.

4. An increase in hydrogen-ion concentration of the fluid in which bacteria are suspended during their exposure to ultraviolet light increased the velocity of the bactericidal action. The accelerating effect began at P_h 4.6, the isoelectric point, and was very strong in fluids more acid than this.

5. Neither temperature nor the hydrogen-ion concentration rendered bacteria sensitive to the longer wave-lengths of light.

SHERK, HENRY H. Total Transposition of Viscera. *Surg., Gynec. & Obst.*, July, 1922, xxxv, No. 1.

Aristotle's writings show that he had observed two instances of transposed organs in animals.

Petrius Servius, in 1615, recorded the first human case as occurring in Rome, but Carl Beck states that the first authentic case was reported in the time of Molière, in the person of Marie de Medici, Queen of France.

Kuechenmeister was the first to recognize the condition during life, based on the examination made by percussion and auscultation.

According to Sorge, the first *x*-ray record of this condition was made by Vehemeyer in 1897.

In 1865, Grueber collected 79 cases from the literature, only five of which had been recognized during life.

Kuechenmeister, in 1888, collected 149 cases. By 1895, Pic was able to collect 190 reported cases, and in 1902 Arneil added, including his own, 44 more, 38 of which were recognized during life.

Karashuma, in 1912, catalogued over 200 cases and gave what is presumably the best historical resumé.

A communication from the Mayo clinic states that a hurried search of their records shows 10 cases indexed since 1910. From the same period their registration was approximately 347,000, or 1 case in 34,700, which compares with the writer's cases, found in 35,000 army recruits examined by him.

Transposition may be total or partial. The former is by far the more common. The latter is very infrequent. This is especially true of true congenital dextrocardia, as an isolated condition, of which Schreotter says: "None, not combined with transposition of other viscera, have actually been confirmed by autopsy."

Total transposition of viscera is apparently twice as common in men as it is in women, and when occurring in women it has no effect on their child-bearing ability.

Statistics on which to base the incidence of heredity could not be found in literature, no case having been recorded in which the condition occurred in parent and child. Brimblecombe reports one instance of two cases in the same family, brother and sister. It has been suggested that twin pregnancy may have some relationship to the condition, but the writer has no knowledge of such a causation.

Bryant, John. Visceroptosis: Normal Incidence. *J. Am. M. Assn.*, Oct. 29, 1921, lxxvii, 1400.

The author is reporting large series of statistical studies based on extensive post-mortem observations which ought to be of great interest to every roentgenologist. His charts are based on 1966 observations on 290 unselected post-mortem sections of all ages and both sexes. The original articles should be valuable to every diagnostician. The author's summary is as follows:

1. Visceroptosis is, in general, not progressive with age. This is due to the fact that, although the percentage of ptosis of certain viscera increases with age, this percentage increase is offset by a decreasing frequency with age in respect to other viscera.
2. Visceroptosis affecting one or more organs was present to some extent in 48 per cent of all cases examined, it being extreme in 10.2 per cent of the males and 19.7 per cent of the females.
3. Visceroptosis affecting the liver, right and left kidney, stomach and pylorus, is acquired.
4. Visceroptosis affecting the large intestine is in both sexes largely congenital or developmental. The percentage frequency of ptosis of certain portions of the large intestine does, however, further increase with age in both sexes. The greatest discrepancy between the male and female in regard to the percentage frequency of coloptosis in the adult occurs at the ileocecal valve. Thus, this portion of the colon shows an extreme degree of ptosis in 12.1 per cent of the males of all ages; this contrasts with an extreme degree of ptosis at the ileocecal valve in 39.4 per cent of the females of all ages.
5. No normal standard of frequency of visceroptosis, based on unselected material, exists.

In the absence of such a normal standard, proper evaluation of the degree of deviation reported in any selected roentgenologic or other series of cases is impossible.

A standard of frequency of visceroptosis which may be considered adequate until corrected by future investigators is made available in tabular form in the present article.

Lawrence, R. D. The Effect of X-Rays on Enzyme Action. *Arch. Radiol. & Electroth.*, Jan., 1922, xxvii, 244.

The literature on this topic is scanty and the results contradictory. After careful study by a method which is described in detail in the original article, the author concludes that radiation has no effect on enzyme action as shown by the method he employed, and therefore the effect, if any, is extremely slight and of no practical importance.

Roberts, R. E. A Case of Extreme Dilatation of the Duodenum Due to Chronic Obstruction. *Arch. Radiol. & Electroth.* Jan., 1922, xxvi, 237.

The author reports a rare case of extreme dilatation of the duodenum in which immediately after the opaque meal the stomach was found to be normal, the duodenal bulb not being seen. After two hours the stomach was seen to be emptying normally, but that barium which had passsed out was seen to be lying at the bottom of a large C-shaped sac with its lower border low down in the pelvis. Above the barium shadow the sac was seen to be almost filled by fluid capped with gas. The upper free level of this fluid showed as a horizontal line above and to the right of the pylorus. A trace of barium could be seen on the floor of the upper arm of the C. The middle portion of the sac is traversed by delicate circular bands. The lower portion of the sac could be freely moved over the abdomen, especially on the left side; this was more evident in the lying-down position. Six hours and twenty-five minutes after the meal a considerable residue of the barium food was still present in the stomach, together with a large amount of secretion; the sac described above could be made out at this and all subsequent examinations up to forty-eight hours, a very small residue of barium being still visible in the stomach. An *x*-ray diagnosis of dilated duodenum was made. At the duodenojejunal flexure a crescentic band of cicatricial tissue was found, which caused a partial stenosis of the gut at this point. About 2 in. below this there was a hernial orifice in the mesentery of the jejunum, through which almost the whole of the remainder of the small intestine had passed, but there was no evidence of obstruction of the small bowel at any point other than the above.

Scholz, Thomas. A Roentgenological Contribution to the Diagnosis of Spinal Carcinoma in Cases Having an Unrecognized Primary Focus. *New York M. J.*, Nov. 15, 1922, cxvi, 566.

Early diagnosis of spinal metastasis in cases showing no apparent primary focus is very difficult. It may be arrived at by means of a thorough and careful analysis of its only symptom, pain, and a careful observation of the course of the disease with its characteristic remissions. Presence of a round gibbus strongly speaks against spinal tuberculosis. Sciatica in elderly people, especially if bilateral, is suggestive of neoplasm of the lumbar spine. Radiographic examinations may prove to become of great diagnostic help early in the disease. They should be made repeatedly and should be arranged individually according to the clinical aspect of the case. They should not be limited to the part of the spine called for, but should include the entire spine and such other parts of the body as may be suspected of having some bearing upon the diagnosis, especially the skull and upper parts of the femora. The radiographic appearance of the metastatic changes may give a suggestion regarding the true nature of the unknown primary focus. Mechanotherapy seems to be very harmful in cases of spinal metastases and should therefore be made use of with great care in spinal conditions. An early diagnosis in spinal carcinoma may give hope of a cure in cases like the first one reported, where the secondary involvement was solitary and comparatively small, and the primary focus, if recognized, could have been removed surgically. Deep *x*-ray therapy in such cases may save the patient's life.

Pfahler, George E. The Treatment of Skin Cancer by *X*-Rays, Radium and Electrocoagulation. *New York M. J.*, Nov. 15, 1922, cxvi, 553.

The author urges that precancerous lesions such as warts, moles, keratoses, and slowly-healing fissures should be destroyed by electrocoagulation, and in this way a great many cancers can be prevented. Every case of epithelioma should be thoroughly treated and completely eliminated at once. It is unwise to destroy cancer piecemeal. Radium properly applied is the best single agent in the treatment of cancer. In all well-advanced cancers two or more methods can generally be combined to advantage in the complete elimination of the disease. Skill, keen judgment, and careful consideration of the individual patient count for much in this field, as they do in every other branch of medical science.

Thomas, B. A., and Pfahler, G. E. Technique of the Treatment of Carcinoma of the Bladder and Prostate by a Combination of Surgery, Electrocoagulation, Radium Implantation and Roentgen Rays. *Arch. Surg.* Mch., 1922, iv, 451.

A very interesting and attractive method of combination of surgery and radiological treatment of bladder and prostatic malignancies is described. In some cases the application is through a suprapubic cystotomy, and in others through a perineal incision for exposure of the prostate and accurate needling with radium needles. Electrocoagulation was used in a certain number of cases. Employing this combination, or quartet, of therapeutic measures, 26 patients have been treated. It is true that originally, in a few cases, the authors' methods, with the present technique, were comparatively crude in some respects. Until three years ago, when the small needles came into use, they were obliged to plant the radium en masse into the growth or its bed; also, the electrocoagulation of the growth was not so intensively and thoroughly done; indeed, in some instances, the tumor was destroyed or removed by the electrocautery, prior to the implantation of radium.

Nevertheless, it is a remarkable fact that in this series of cases, although some patients have not been relieved of their symptoms, or their symptoms have returned after a period of improvement or actual freedom, only two are known to be dead, and one has been untraceable, a result that could not have been paralleled by any other form of treatment. The majority of these patients have been treated and observed only during the last three years; therefore, the authors are not justified in drawing conclusions, nor is it their intention to make any particular claims as to end-results. They desire simply to describe the technique evolved from experience and at present employed in this surgically unwelcome and disheartening type of formerly inoperable bladder and prostatic carcinoma, and to say that it is their conviction that the treatment here described and practiced offers more in the way of prolongation of life, if not cure in a few rare instances, than any other method of treatment heretofore employed in this particular deplorable type of malignant disease.

Heckel, Edward B. Non-Surgical Treatment of Malignant Epibulbar Neoplasms. *Arch. Ophth.*, Mch., 1922, li, 141.

The author, in 1915, reported a case of epibulbar sarcoma treated with roentgen rays in 1910 with a technique which resulted in complete cure of the malignancy and the preservation of a perfectly functioning eyeball. The success in this case was, the writer believes, the result of keeping the anterior segment of the eyeball wet during the exposure to the roentgen ray, by the continuous dropping of a normal salt solution over the eyeball. Since then, he has been able to discard the salt solution, due to better and more efficient *x*-ray tubes. The technique employed in the following cases consisted of placing the patient in a recumbent, comfortable position, the face covered with a piece of tin foil perforated with a small hole a little larger than the neoplasm, and so placed that when the patient was directed to look in a certain direction the aperture in the tin foil was directly over the neoplasm. This procedure permits the patient the free use of the eyelids so that he may wink as often as he desires; in this manner the cornea is kept moist and cannot dry.

Case I. Epidermoid carcinoma of right eye treated by Dr. George W. Grier. First application 5 ma. current; 6½ in. parallel spark-gap; anode skin distance 8 in.; no filter; time two and a half minutes. Five days later same treatment repeated; three days later same treatment with three instead of two and a half minutes; four days later same treatment as on the third exposure. After these four treatments the patient was given twenty-one days' rest. At the end of this time there was still a small part of the growth remaining. Fifth exposure twenty-four days after the fourth, this time with 10 in. spark-skin distance, three and a half minutes. Sixth exposure, three days later, the same as the fifth except three minutes. The seventh exposure, two days later, the same as fifth exposure. One month later, lesion was completely healed and remained so.

Case II. Squamous-cell carcinoma, right eyeball. Treatment again by Grier as outlined above, twelve exposures being given during seventy days. Photographs of the patients and microphotographs of the tissue removed at biopsy accompany the article. The author calls attention to the necessity of adding treatment with the actual cautery or electrocautery in certain cases where the neoplasm protrudes through the lid aperture.

Regaud, Cl. The Error of Division and Too Frequent Repetition of Doses in the Radiation Treatment of Cancer. *Paris Med.*, Feb. 4, 1922.

According to this author, the cure of a cancer requires the destruction of all the malignant cells. The time during which the total dose necessary for its destruction can be administered is variable. Often, however, cancers are treated by small doses, frequently repeated, during a long period of time. There are two objections to this division and frequent repetition of doses. On the one hand, the repetition of non-lethal doses of irradiation produces a sort of immunity on the part of the neoplastic tissue. On the other hand, there is brought about a sensitization of the normal tissues. This condition is frequently observed in superficial malignancies on the face. Where this technique has brought the progress of a lesion to a standstill, and on account of ulceration no further radiation can be given, it is important, then, to administer the total treatment of a cancer at one application if one wishes to achieve a complete cure.

Bryant, John. Visceral Adhesions and Bands: Normal Incidence. *Am. J. M. Sc.*, Jan., 1923, iii, 165.

This paper is a continuation of studies already noticed in these columns, undertaken by Bryant on a large series of unselected postmortem sections. The following conclusions are of great interest to diagnosticians, especially roentgenologists.

The transverse colon is more frequently involved by adhesions than any other abdominal viscus. Seven women and eight men out of every ten persons presumably have some involvement of this viscus by congenital or acquired adhesions. Next in order of frequency of involvement come the gall-bladder, duodenum, peritoneum, omentum, ascending colon, hepatic flexure, appendix, liver, and descending colon.

Within a range of variation not usually exceeding 10 per cent, the rate of involvement of a given viscus may be greater in the male or in the female, and this relative rate of involvement with regard to sex may further vary with age.

The rate of involvement by adhesions is for several viscera higher in the fetus than at later ages, as the transverse colon in the male and the terminal ileum in the female.

The rate of involvement by adhesions increases rapidly with progressive age for certain other viscera, as the sigmoid flexure in the male and the adnexa in the female.

The age of forty is critical in both sexes with reference to the average number of viscera involved by adhesions in any given case. After the age of forty, there is a sudden increase of involvement by about 50 per cent in both sexes, the increase being somewhat more marked in the male than in the female.

Complexity is practically a synonym for age with regard to the number of viscera involved in any given adhesive process. This increase in complexity amounts to over 200 per cent after forty years of age.

Variety in the character of the adhesions present also increases with age. A sudden marked increase of nearly 100 per cent occurs in the thirty-forty year decade, or ten years earlier than the onset of the marked increase with regard to the average number of viscera involved, and the onset of the increase in the complexity of the adhesions themselves.

The distinguishing characteristics of congenital or developmental adhesions are simplicity and lack of variety in type.

The distinguishing characteristics of acquired adhesions are complexity and variety in type.

Poos, Fritz. Concerning the Indirect Damaging Effects of Irradiation on the Body through Irradiation of Isolated Organs. *Klin.-therap. Wchnschr.*, Apr. 22, 1922, p. 836.

No evidence has been found for the possibility of influencing the specific function of the hypophysis through *x*-ray irradiation. The infantile development of the genitalia which occurs on *x*-ray irradiation of the hypophysis is not dependent upon hormones and should not be considered analogous to the constitutional infantilism. The genital infantilism is considered as part of the phenomena of a typical general deterioration brought about by generalized indirect action of the rays. In all the irradiated (*x*-rayed) animals, whatever the place chosen for irradiation, the condition of the organs was essentially similar to the condition of organs exposed to the direct action of the rays—a typical deterioration of the organs with increased metabolic rate (changes) in the cells.

Groover, Thomas A. The Relation of Radiology to Cancer Control. *South. M. J.*, Jan. 1923, xvi, 11.

The author regrets the fact that in much of the literature on cancer intended for both lay and professional distribution, radiology is referred to mainly for the purpose of warning against it; and by broad implication, at least, the motives, good faith, and professional competency of the radiologist are impugned. Under the guise of a public health crusade, leaders in medical thought have also given expression to similar sentiments on the public platform and through the columns of the daily press. It is doubtful that the exigencies of the situation, or the facts in the case, justify such dogmatic pronouncements, which do not foster that helpful cooperation essential to the success of such movements.

In mapping out a plan of attack upon cancer, or a potential cancer, we have not always a clear conception of the issue involved, namely, that in most instances it is a question of life or death, and that, if we fail to destroy the cancer utterly and completely, the cancer will inevitably destroy the patient. We do not always properly balance our treatment of the patient and our treatment of the disease. The radiologist has been unduly handicapped by the prevailing idea that under no circumstances must he do anything that would jeopardize the vitality of a healty cell. Until he is allowed some of the latitude in this regard that has been by common consent conferred upon the surgeon, his efforts in combating cancer will fall short of the goal.

The author believes that the time will come when we shall say that this particular case is a case for *x*-ray and that particular case is a case for surgery. It is not logical to use two entirely unrelated methods having the same therapeutic object.

Morton, Reginald, and Lee, Harrie B. Some Results of Deep X-Ray Therapy. *Lancet*, Jan. 30, 1923, civ, 117.

The authors state that the time has not yet come for them to analyze their results in deep *x*-ray therapy in malignant disease, although they now have over 600 cases to refer to, for the following reasons: (1) Over 95 per cent of the cases treated have been sent up by surgeons or others with the comment "inoperable" or "inoperable recurrence after operation." Such being the case, the percentage of good results is necessarily small, and any figures based on such results would be misleading. (2) In a large majority of cases treated, general dissemination had already begun, and, although the primary focus has disappeared after treatment, death has quickly ensued from involvement of the liver, mediastinum, etc. Here, again, figures would give quite a wrong impression of the results. (3) In regard to the comparatively few early cases treated, the longest interval since signs of the disease have disappeared is only eighteen months, a period quite inadequate within which to say whether they are to be classed as cures or not.

Nevertheless, the authors, feeling that the medical profession would welcome some information on results to be expected from treatment, cite a few cases, giving full details of treatment and results. The case reports would indicate that the method has now fairly well established itself as a means of dealing with cases when nothing else can be done. The results in all cases make the treatment worth while, and in a few instances border on the miraculous. Whether an early case of surgery should be discarded in favor of *x*-rays, it is as yet too early to say; but in all early cases treated, symptoms and signs have disappeared, and so far there has been no recurrence. When surgery is resorted to, the authors strongly urge the employment of deep *x*-ray therapy either before or after operation—preferably before, as a prophylactic measure against recurrence.

Smith, Morris K. Premature Ossification After Separation of the Lower Radial Epiphysis. *Ann. Surg.*, Apr., 1922, lxxv, 501.

The author reports a case of very great interest because of the clear roentgenographic demonstration of premature ossification of the previously separated epiphysis, resulting in arrested growth. The process in the radius was observable in eight months and complete in one year. Another feature of interest is the accompanying ossification in the ulna epiphysis, although the original injury here was a fractured styloid.

Erskine, Arthur W. X-Ray Treatment of Carcinoma of the Breast. *Illinois M. J.*, Mch., 1922, xli, 209.

The author believes that at the present time from ordinary intensive radiation of breast cancer we can reasonably expect:

1. An increase of at least 25 per cent in the number of patients alive five years after operation.
2. Prevention of breaking down and ulceration of the tumor, with its attendant pain, foul odor, and mental anguish. He has seen only one inoperable case break down under *x*-ray treatment.
3. Destruction of superficial metastases.
4. Prolongation of comfortable life.
5. An easy death from distant metastases or intercurrent disease.

The question as to whether or not an attempt should be made to administer a lethal dose to the whole cancer at one sitting is as yet undecided. It is evident that flooding the chest with such a tremendous amount of radiation at one time will produce such a profound constitutional reaction that we should have to be prepared to accept a definite mortality rate from the treatment alone.

Finally, the *x*-ray therapist must remember that he is dealing with a powerful agent, capable of producing harm as well as good. He must remember that insufficient treatment of cancer cases takes away the only chance these patients have for life. Realizing the deadliness of the disease, he must be willing to submit his patients to considerable discomfort, and he must not fear burns of the skin, or even a few deaths. In order to attain the highest degree of success, and to realize the hopes inspired by recent developments in this art, a certain degree of courage is as essential as a mastery of technical details.

(Surely the view expressed in the last two paragraphs of this abstract is an extreme one. The occurrence of deaths in connection with radiotherapy can only serve to discredit it. Ed.)

BOOK REVIEWS

Bronchoscopy and Esophagoscopy. By Chevalier Jackson, M.D. Octavo of 346 pages with 114 illustrations and 4 color plates. Philadelphia and London, 1922. Cloth, $3.50 net.

As stated in the author's preface, this book is an abstract of his previous work, "Peroral Endoscopy and Laryngeal Surgery," published in 1915.

The former treatise was a large heavy volume of over 700 pages. The new volume is in the form of a manual containing less than half the number of pages. The difficult task of presenting by written word the various purely manual endoscopic procedures has been accomplished in the same brilliant manner in which the distinguished author has so successfully solved the many perplexing and unusual problems of endoscopic surgery.

In the main, the author has confined himself to a clear, concise description of the technical details of endoscopic work, which, in his judgment, based on a wide clinical experience, have proved to be the best methods. Consequently the reader is not confronted with a multiplicity of procedures or confused by a mass of historical data. Yet the pruning has been so skilfully accomplished that nothing vital has been sacrificed, and one may confidently predict that the new work will bear fruit in even greater abundance than the older treatise. It instructs and does not weary, it pilots but does not explore. His love of accuracy of statement has prevented creating superfluities, as has his fear of prolixity prevented important omissions.

In his first chapter, "Instrumentarium," he very properly avoids citing the numerous types of endoscopic tubes that have been devised since the development of endoscopic surgery, and confines himself to a description of the distally lighted tubes which bear his name.

The chapter on "Anatomy of the Larynx, Trachea, Bronchi and Esophagus Endoscopically Considered," has been treated at greater length and in more detail than in the older treatise.

The position of the patient in endoscopic examination is also explained in greater detail, and especially helpful are the new drawings showing the schema of position for endoscopic examination—the normal recumbent, the raised flexed, the raised extended and the faulty position with chest heaved and spine arched.

In that portion of the work dealing with "Symptoms and Physical Signs of Foreign Bodies in the Air and Food Passages," the author has arranged in epitomized, compact and yet detailed form, all the latest results of numerous keen observers and careful clinicians. Especially instructive is the well-arranged summary on "Symptomatology and Diagnosis."

The "Roentgen-ray Study in Foreign Body Cases" has been considerably condensed. Some of the newer roentgenographic signs: viz., expiratory valve-like bronchial obstruction produced by nonradiopaque foreign bodies such as peanut kernels, have been described. One might wish that the author had explained in greater detail the method of bronchial mapping or lung mapping by the bronchoscopic introduction of opaque substances such as powdered subnitrate of bismuth. The results have been well illustrated with photographic copies of *x*-ray plates of actual cases.

The chapter on tracheotomy is a valuable and sorely needed addition to medical literature. It contains the clearest, most condensed description and résumé of the indications for tracheotomy, the technique of the operation and the after-care of the patient, that the reviewer has yet seen.

If one were to summarize the virtues of this new work of Jackson's, he could not do better than to say that it comprises all the elements which, in our undergraduate days, we were taught constituted an ideal sentence, namely: Correctness, Clearness, Force, Ease and Unity.

Edward L. Pratt.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X APRIL, 1923 No. 4

PNEUMOPERITONEUM*

BY HUMBERTO H. CARELLI, M.D.

BUENOS AIRES, ARGENTINE

INTRODUCTION

HAVING had an experience of over 800 cases of pneumoperitoneum, I should like to demonstrate, by some of the results obtained, the harmlessness of this method when it is performed with an appropriate technique (including the procedure adopted in making the pneumoperitoneum and the manner of taking the roentgenograms).

Mention should be made here that all the cases of pneumoperitoneum which I have had, have been personally attended by me in my private office, without assistance, and that all the patients have left my consulting rooms perfectly well and without feeling any ill effects; indeed, in several cases the same patient has been pneumoperitonized on three different occasions.

The inconveniences which have been published are, in my opinion, due to ignorance on the part of the operators, because, firstly, they have employed a faulty technique, and secondly, they have not been well equipped in their installation. The dangers which have been published, such as *puncture of omental or mesenteric blood-vessels, puncture of abdominal viscera, and air embolism* may all be avoided by introducing the needle at the right point of the abdomen, and waiting until it is seen that blood does not flow through the needle. Peritonitis can be avoided by a knowledge of the most elementary rules of asepsis. Superficial emphysema is an accident which may occur, but is not at all dangerous, and is preventable by using the manometer in the injecting apparatus. Precipitation of cardiac failure can be evaded by examining the patient thoroughly clinically and performing the pneumoperitoneum only in cases where there are no cardiovascular troubles or insufficient myocardium. The fatal cases produced must have been caused by negligence of a thorough clinical examination beforehand.

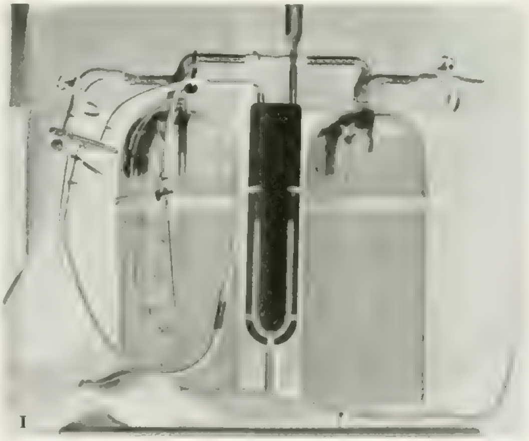


Fig. 1. Apparatus used by Dr. Carelli for performing pneumoperitoneum. This allows one to measure the volume of gas injected and the pressure of same.

On examining my illustrations, it will be noticed that there are many cases in which clinical diagnosis of the pathological condition of the abdomen would have been impossible, and even a surgical examina-

---

* Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922. Discussion on this paper and others in the same symposium will appear in a later number of the JOURNAL.

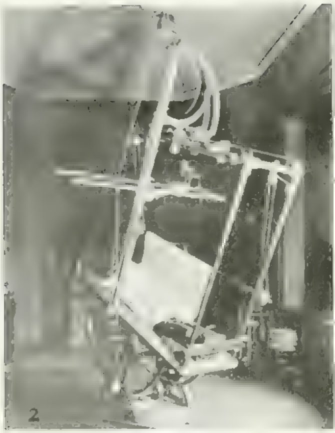


Fig. 2. View of the table with a patient lying on his abdomen and the tube above.

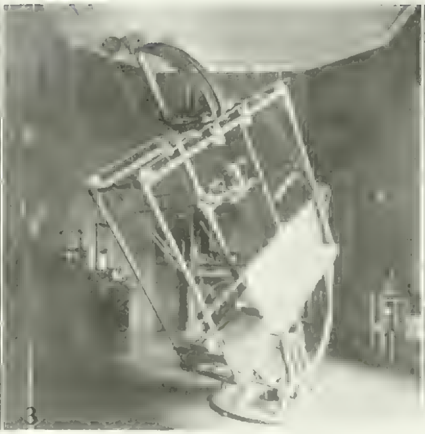


Fig. 3. Another position of the table with a patient in an inclined pose.

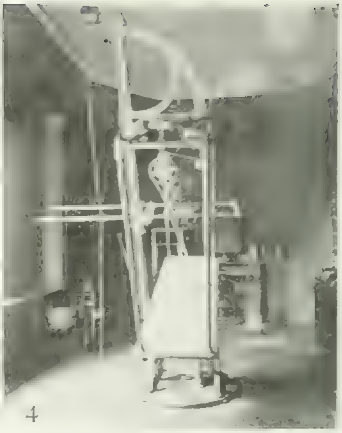


Fig. 4. The table seen from one end

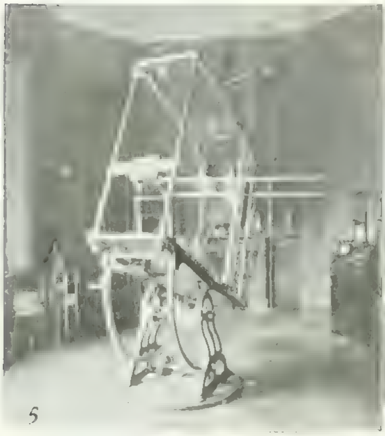


Fig. 5. Another view of the table.

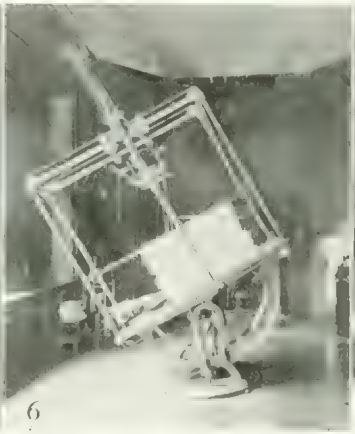


Fig. 6. A lateral view of the table, showing the two half-circles which permit of it being balanced in both directions.

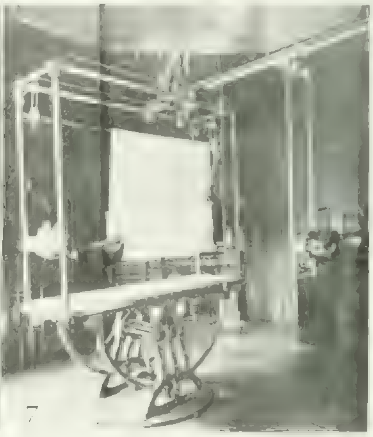


Fig. 7. The table in position to take a lateral view of a patient.

Fig. 8. Lateral and horizontal view of a patient, showing adhesions from liver and intestines to anterior abdominal wall.

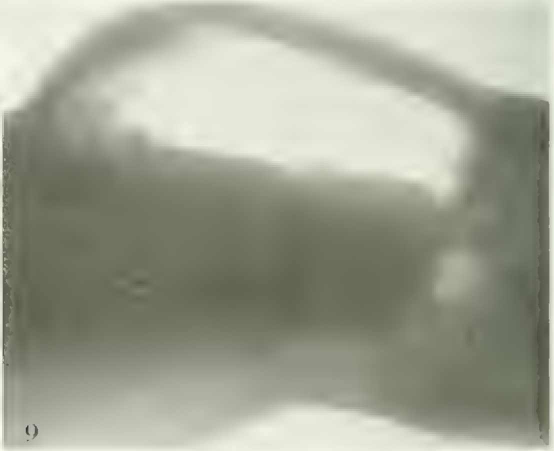


Fig. 9. Lateral view of a patient, showing adhesions to lower part of the anterior abdominal wall.

tion or exploratory operation would have been insufficient to provide the exact diagnosis. Certainly the shock produced by pneumoperitoneum is far inferior to that caused by an exploratory operation, and the results of the radiological exploration are far more complete than those of the surgical examination, because it is possible to see the abdominal wall in all its extension underneath the diaphragm (so difficult to explore surgically) and the posterior wall (also difficult to explore surgically, because the abdominal organs are all resting on its surface).

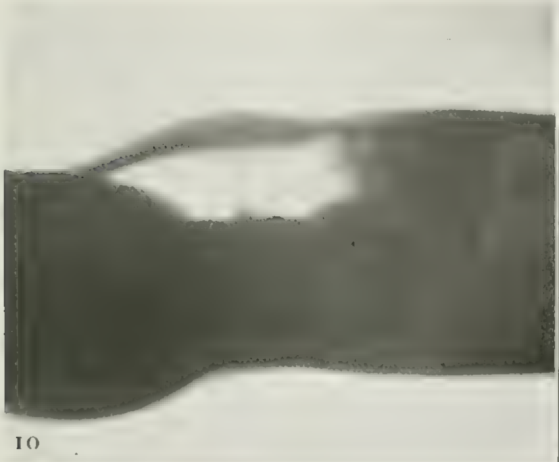

10

FIG. 10. Lateral view of a patient, showing adhesions from liver and epiploon to anterior abdominal wall.

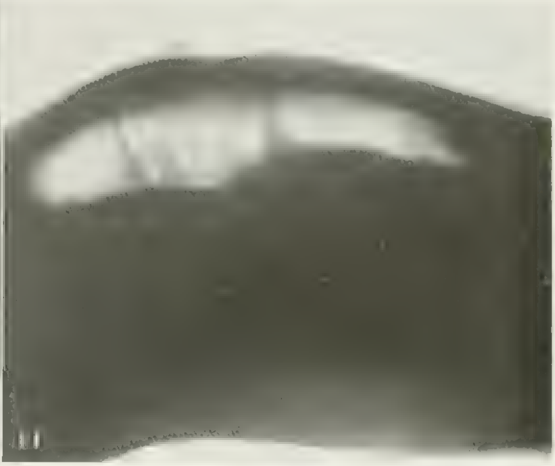

11

FIG. 11. Lateral view of a patient, showing adhesions to anterior abdominal wall from liver and intestines.

Contraindications of pneumoperitoneum are:

1. Old age (generally speaking).
2. Cardiac troubles, insufficient myocardium, etc.
3. Cachexia.
4. Extreme obesity.
5. Acute inflammatory conditions of the abdomen.
6. Hysterical subjects.
7. Cases where a tumor or the tension of the abdomen does not permit further distention of the abdominal wall.

With the advance of roentgenological technique, one can expect to obtain the precise diagnosis by means of pneumoperitoneum; and with the correct interpretation of plates the time will come when it will be possible to make pathological anatomy on living subjects, thus realizing the prediction of the French professor: "L'autopsie sur le vivant."

TECHNIQUE

1. *Preparation of the Patient.* The preparation consists in completely emptying the digestive tube. In order to do this one administers to the patient on two successive mornings preceding examination, a purge, which on the first day may be a dose of castor-oil, and on the second a saline purge. During these two days the patient

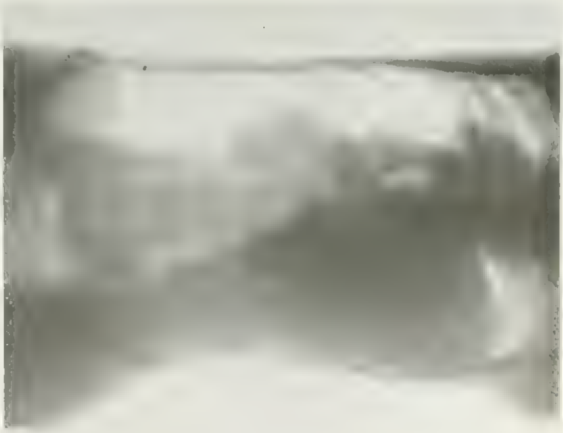
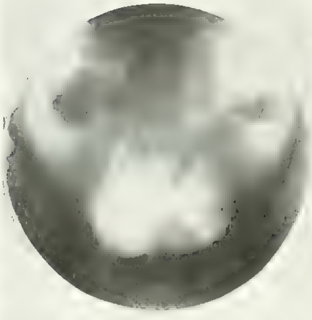

12

FIG. 12. Lateral descending view of a patient lying on right side. Shows left lobe of the liver, spleen and left kidney.

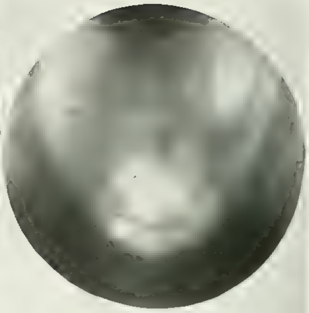


13

Fig. 13. Pelvis, showing the uterus, bladder, ovary and Fallopian tube.

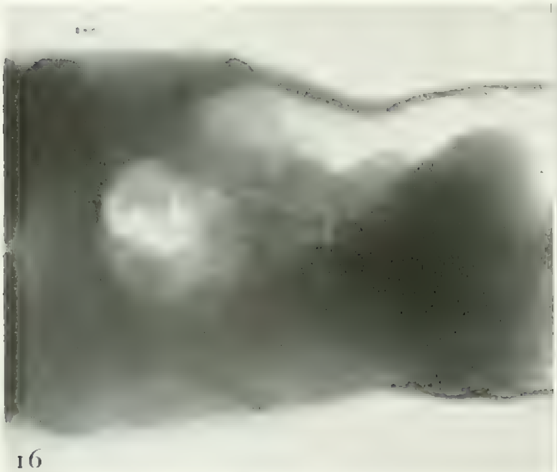
14

Fig. 14. Lateral view of a patient lying on abdomen. Shows lateral view of vertebral column, spleen and both diaphragms.



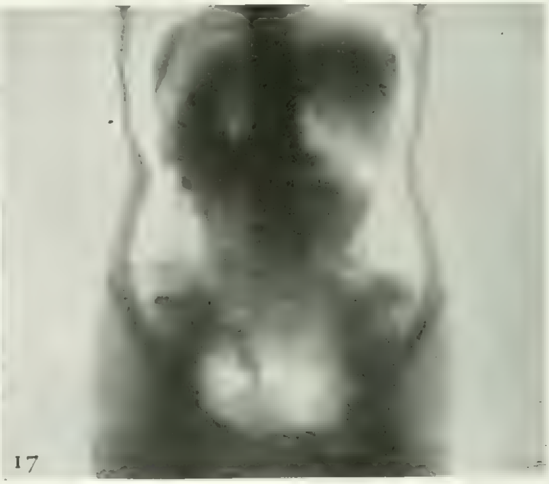
15

Fig. 15. Shows uterus, ovaries and Fallopian tubes.



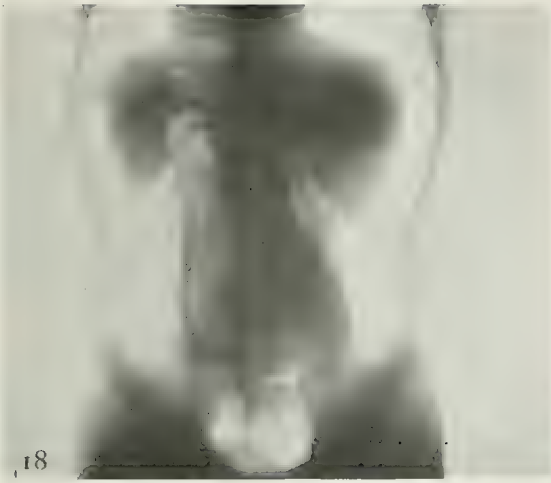
16

Fig. 16. Lateral view of a patient lying on left side. Shows uterus suspended from the round ligament, right ovary, inferior part of the kidney and external border of the liver.



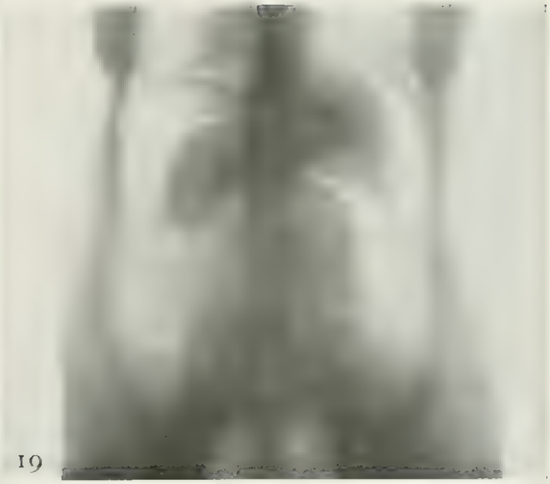
17

Fig. 17. Frontal view of a patient, horizontal position. Shows both diaphragms, outline of both lobes of the liver, large spleen, pancreas, right kidney, uterus and ovaries.



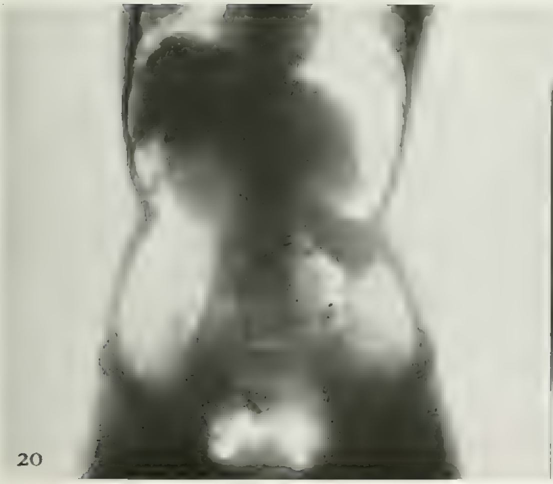
18

FIG. 18. Shows adhesions of liver to right diaphragm, and a single kidney in the shape of a horseshoe.



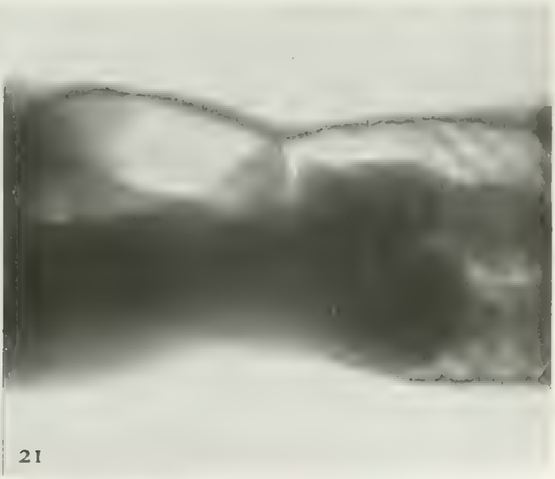
19

FIG. 19. Frontal view of a patient, horizontal position. Shows outline of liver, both diaphragms, right kidney in first degree of ptosis, small and lobulated left kidney. The ureter is seen quite clearly; spleen adherent to the kidney. Diagnosis: Purulent scleronephritis. In the pelvis is seen uterus and both ovaries. Diagnosis confirmed by operation.



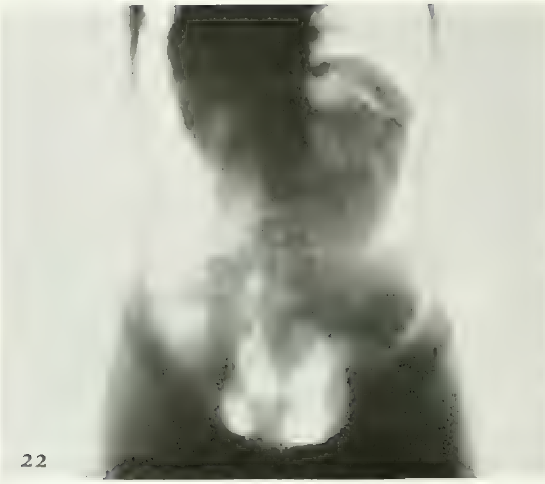
20

FIG. 20. Ectopic kidney adhering to the lateral abdominal wall. Large left kidney, uterus and ovary.



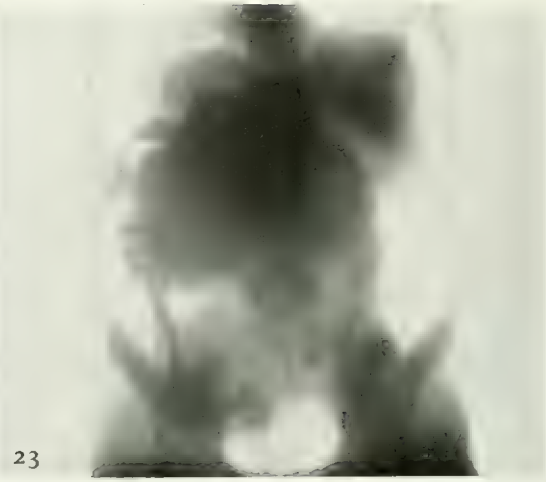
21

FIG. 21. Same patient as seen in Fig. 20, but lateral view. Shows adhesions from ectopic kidney to lateral abdominal wall.



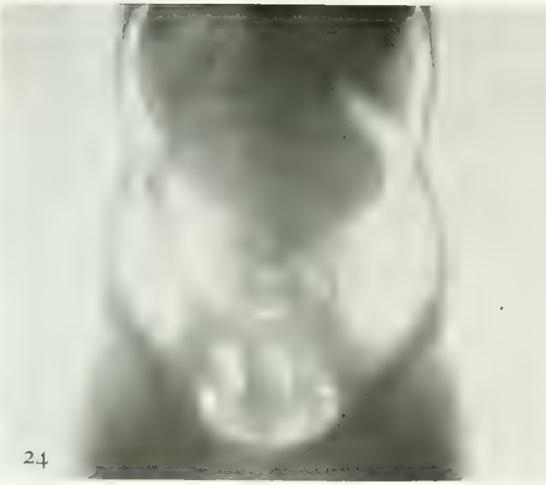
22

Fig. 22. Biloculated echinococcus cyst of left kidney, uterus and both ovaries.



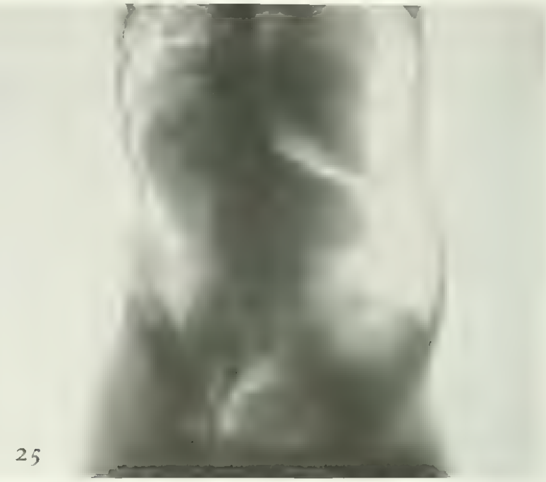
23

Fig. 23. Hydronephrosis of left kidney, showing the descending colon adhering to the kidney.



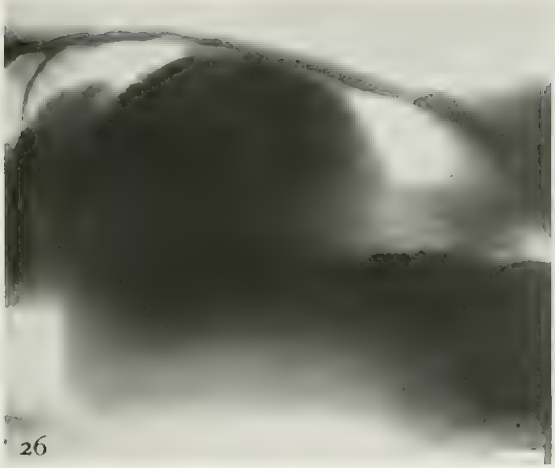
24

Fig. 24. Frontal view of a patient in descending position. Outline of right kidney shows irregularity of its lobulations. Diagnosis: Nephroma. Confirmed by the operation. Uterus, round ligament, ovaries, and bladder, half full, are seen.



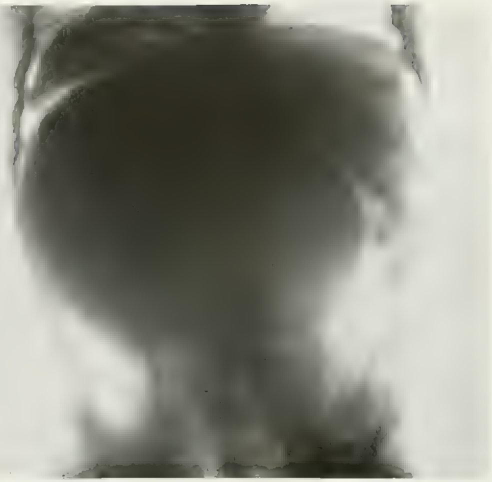
25

Fig. 25. Same patient in oblique position.



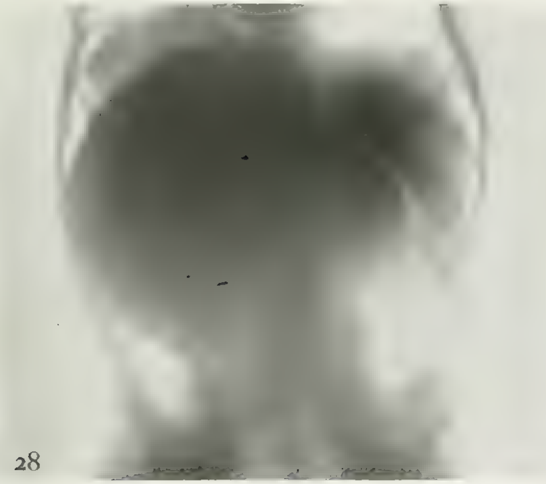
26

FIG. 26. Frontal view of a patient lying on right side. The immense tumor belongs to left kidney, showing adhesions to lateral abdominal wall. Above the kidney the spleen is clearly seen, pushed against the diaphragm by the development of the tumor. Diagnosis: Echinococcus cyst of left kidney. Eight liters of liquid removed.



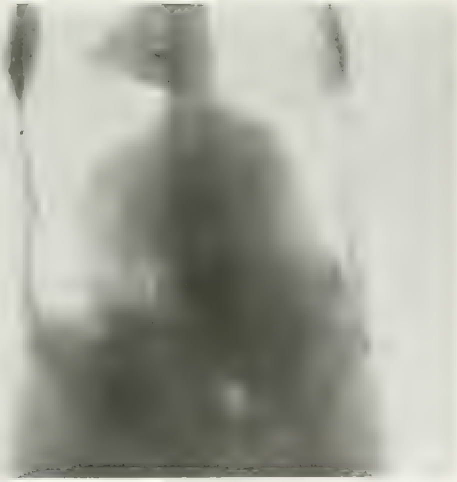
27

FIG. 27. Frontal and ascending view of same patient.



28

FIG. 28. Frontal and horizontal view of same patient.



29

FIG. 29. Frontal view of a patient, ascending position. Large tumor of right kidney on which the liver leaves its impression. Diagnosis: Hydatid of right kidney. Confirmed by the operation.

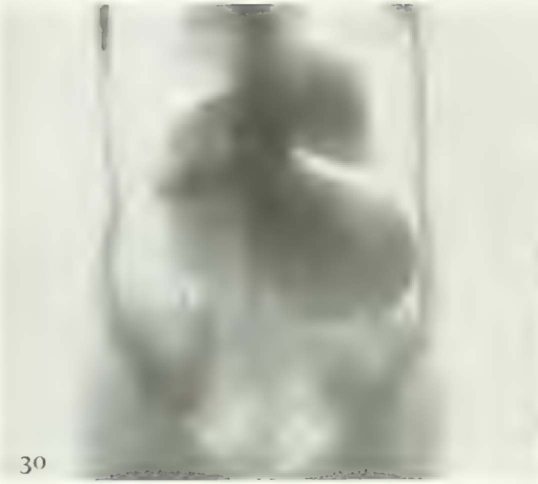


Fig. 30. Frontal view of same patient, horizontal position. Liver, spleen, pancreas and left kidney clearly seen.

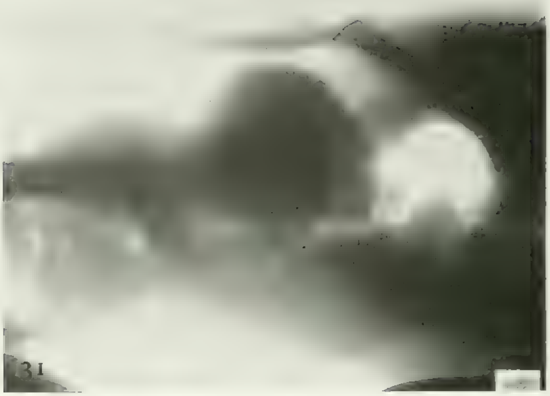


Fig. 31. Frontal view of same patient lying on left side. The tumor clearly seen; uterus suspended from the round ligament.

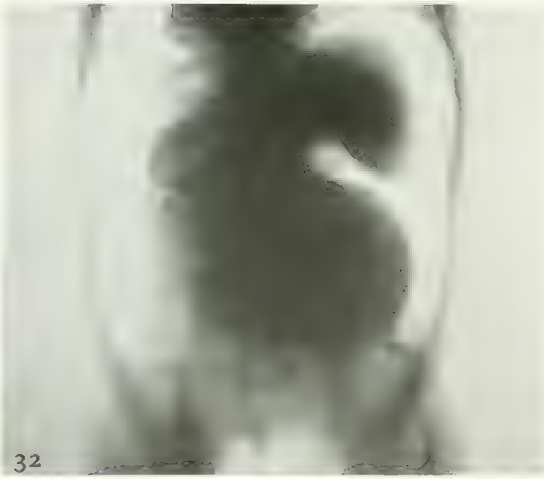


Fig. 32. Frontal view of a patient, horizontal position. The tumor of right kidney clearly seen. Diagnosis: Echinococcus cyst of liver. Confirmed by the operation.

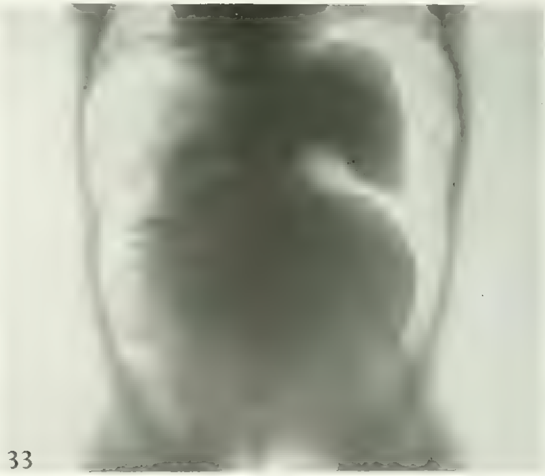


Fig. 33. Frontal view of same patient, ascending position.

34

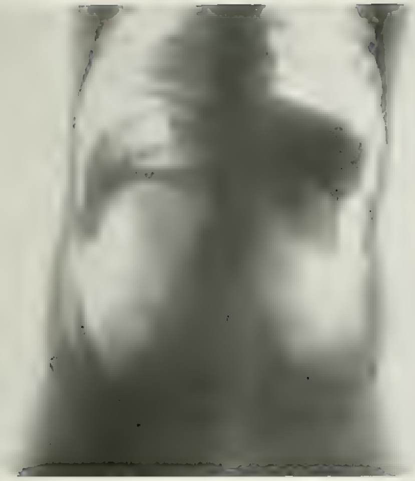


Fig. 34. Frontal view, horizontal position. Exterior border of liver and right lobe shown. Diagnosis: Nucleus of primitive cancer of the liver. Confirmed by autopsy. Pancreas clearly shown in this picture.

35

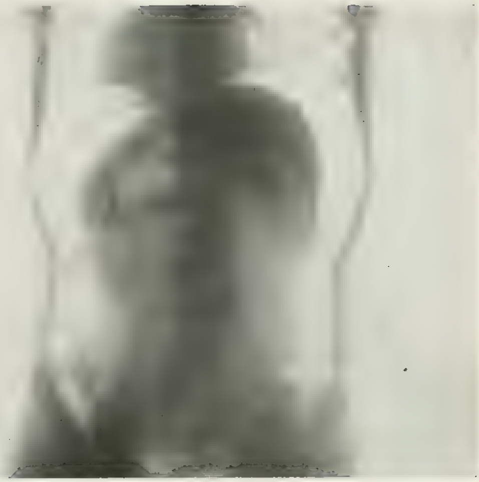


Fig. 35. Frontal view, horizontal ascending position. Shows gall-bladder dilated. Liver, spleen and pancreas clearly seen.

36

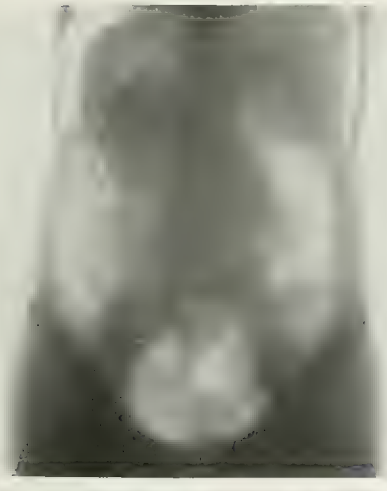


Fig. 36. Frontal view, horizontal position. Shows an abscess on the inferior surface of the liver. Right kidney descended, uterus, etc.

37

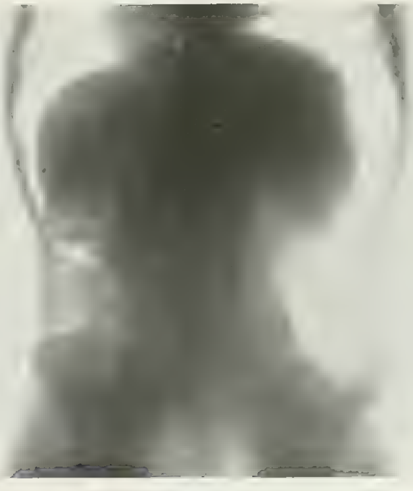
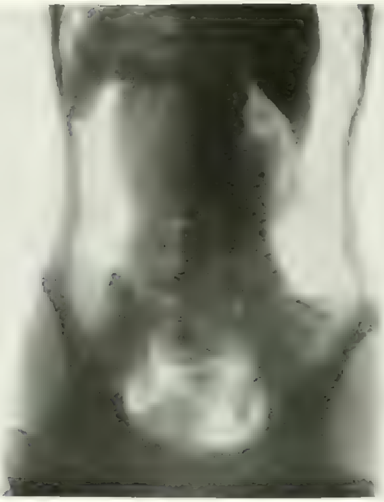
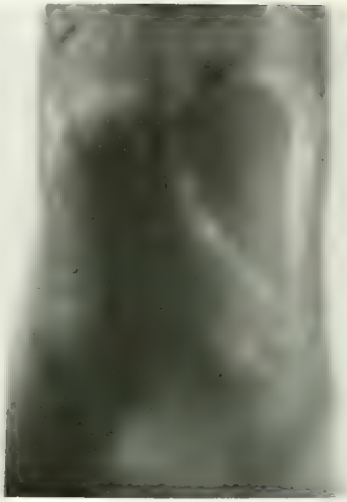


Fig. 37. Frontal view, horizontal position. Patient had clinical symptoms of echinococcus cyst of liver. Diagnosis: Syphilis of the liver. Diagnosis based on the following: Outline of liver not sharp and regular, shows the lobulations of the "foie ficelé," edge of liver rounded and spleen big. Treatment confirmed the diagnosis.



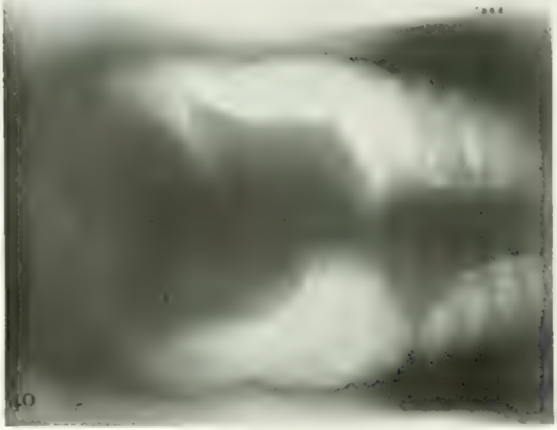
38

Fig. 38. Pancreatic cyst (quiste del pancreas), uterus, ovaries, bladder, etc.



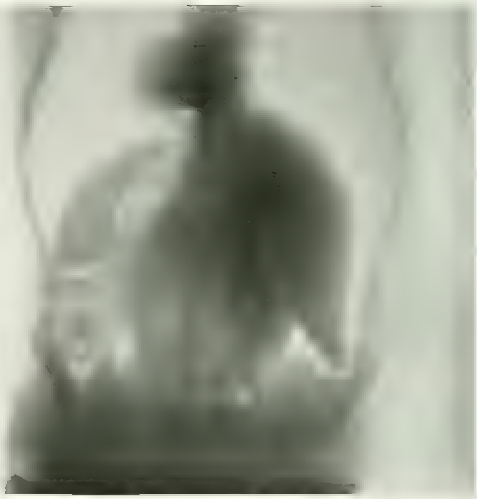
39

Fig. 39. Oblique view of a normal liver.



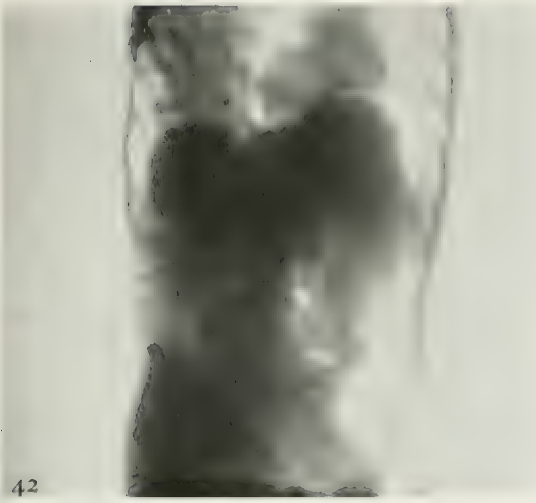
40

Fig. 40. Perihepatitis.



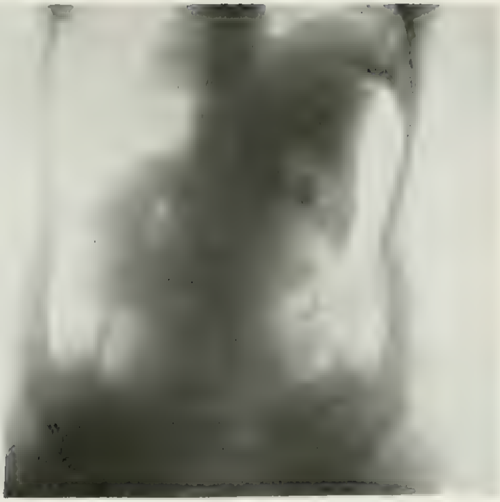
41

Fig. 41. Frontal view, descending position. Distended gall-bladder clearly seen suspended from the liver.



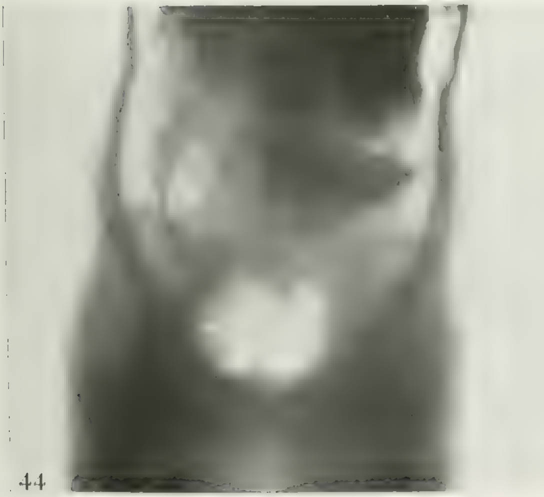
42

FIG. 42. Oblique position. Adhesions between the liver and abdominal wall and distended gall-bladder.



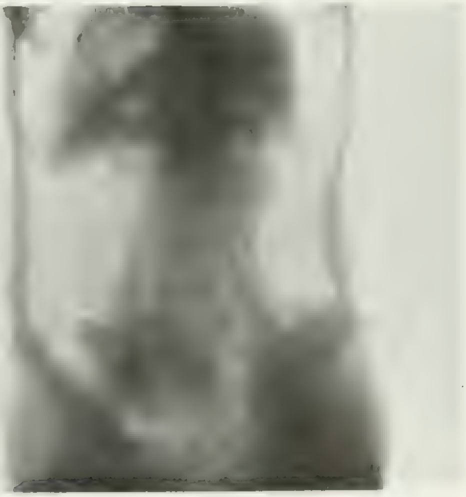
43

FIG. 43. Frontal view, horizontal position, subdiaphragm abscess.



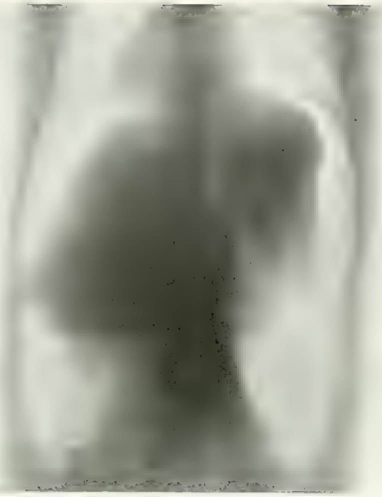
44

FIG. 44. Distended gall-bladder, uterus, ovaries, etc.



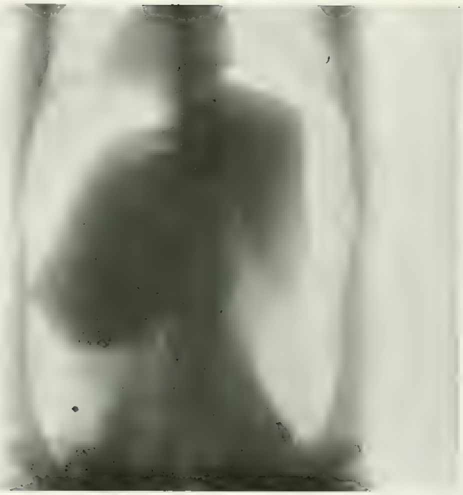
45

FIG. 45. Clearly shows gall-stones, liver, spleen, pancreas and fibroid of the uterus.



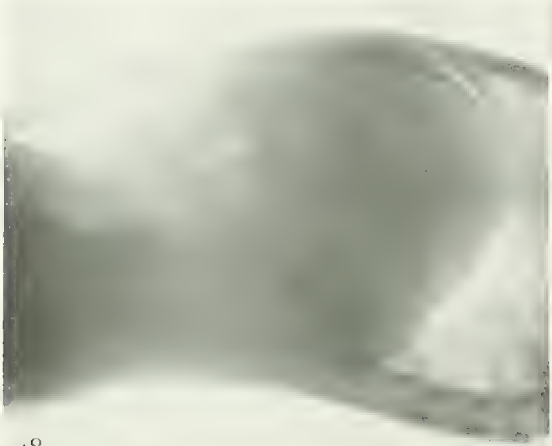
46

Fig. 46. Hydatid of the spleen.



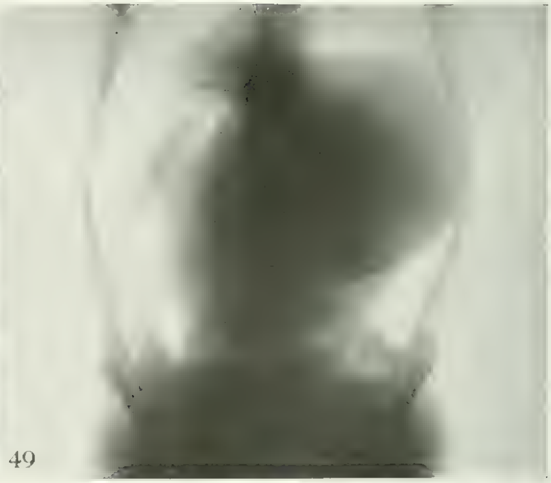
47

Fig. 47. Same patient, descending position.



48

Fig. 48. Lateral view of large hydatid of the liver.



49

Fig. 49. Frontal view of the same patient.

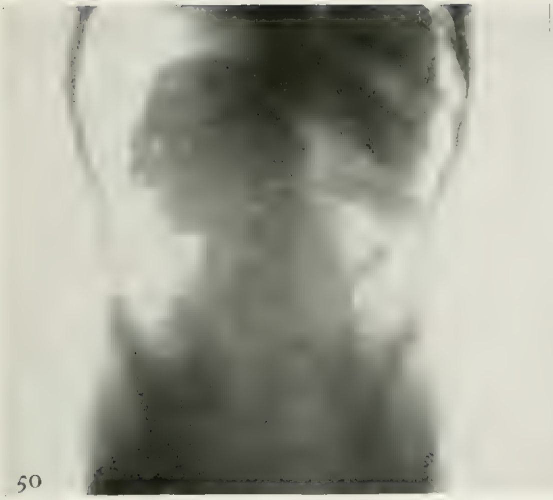


FIG. 50. Pediculated hydatid of right lobe of liver.

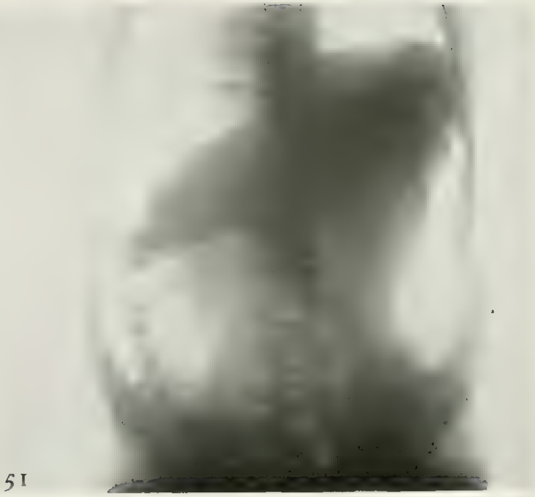


FIG. 51. Hydatid of right lobe of liver.

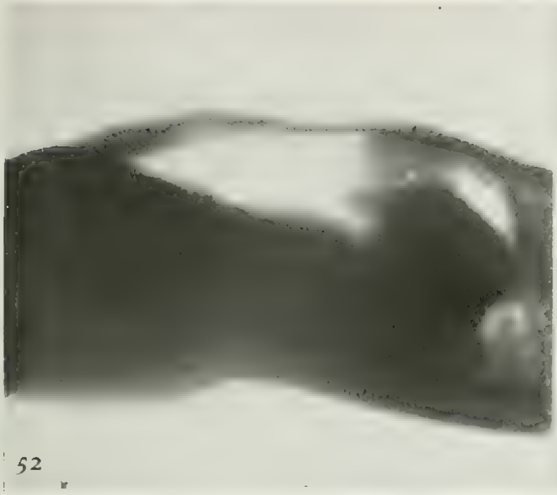


FIG. 52. Lateral view, horizontal position. Hydatid of the anterior abdominal wall in a patient operated upon for echinococcus cyst.

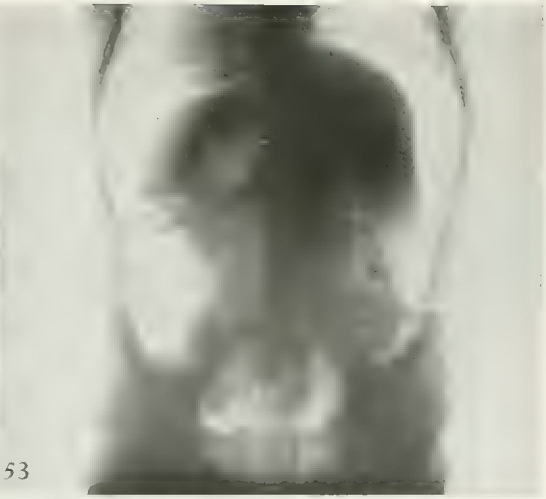


FIG. 53. Frontal view of a patient showing a small hydatid of the rectovesical connective tissue.

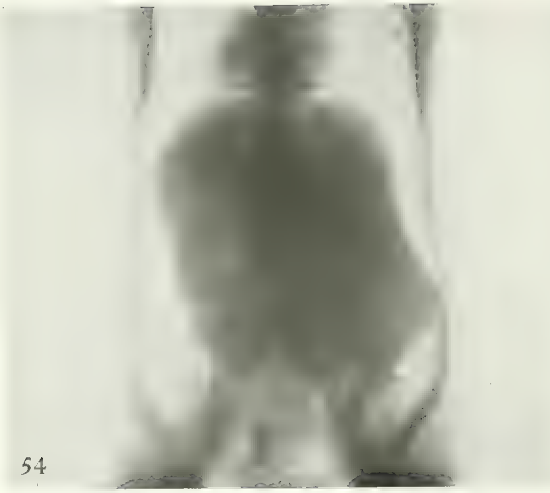

54

Fig. 54. Hydatid of left lobe of liver and pediculated cysts of the right lobe. Spleen pushed downwards by the development of the cyst. Shadow seen underneath is the kidney. Diagnosis: Pediculated cysts of the right lobe of the liver. Diagnosis because the right kidney was seen underneath without being deformed. Confirmed by the operation.

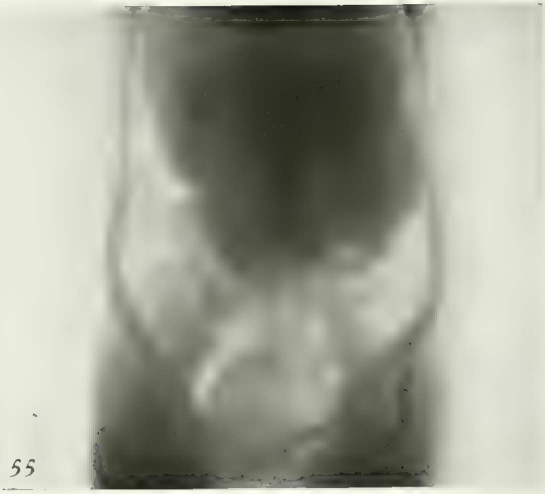

55

Fig. 55. Same patient, descending position, showing uterus pregnant at one month.

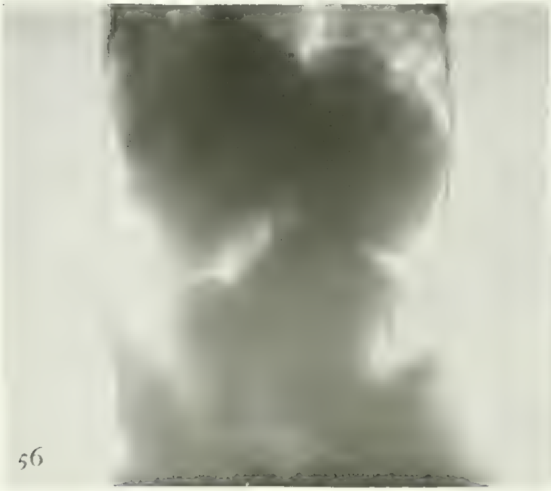

56

Fig. 56. Large hydatid of right lobe of liver. In right lobe also small pediculated one. Hydatid in the spleen and another in the mesenterium.

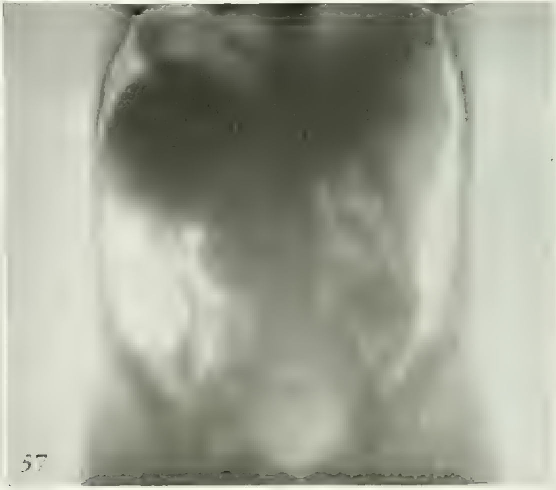
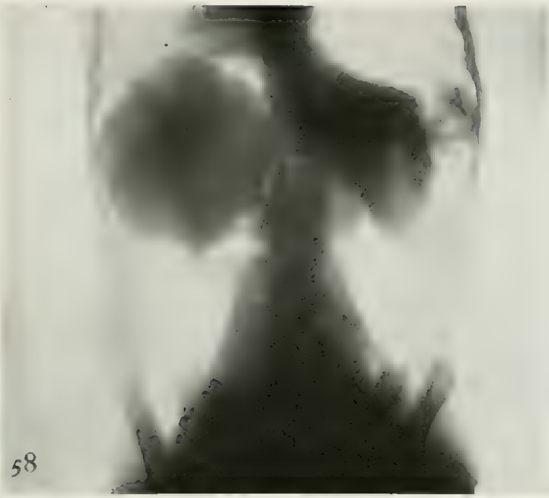
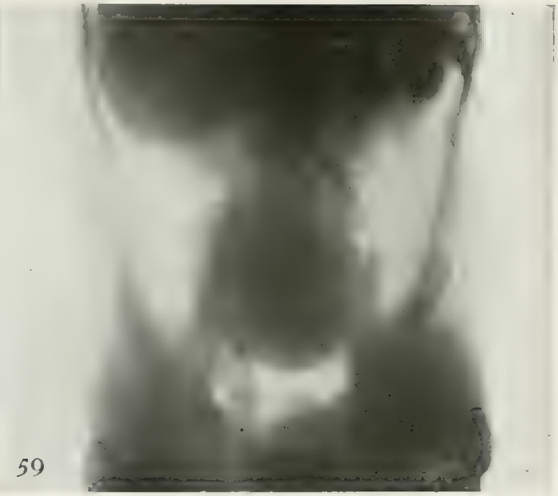

57

Fig. 57. Same patient, showing the cysts above described.



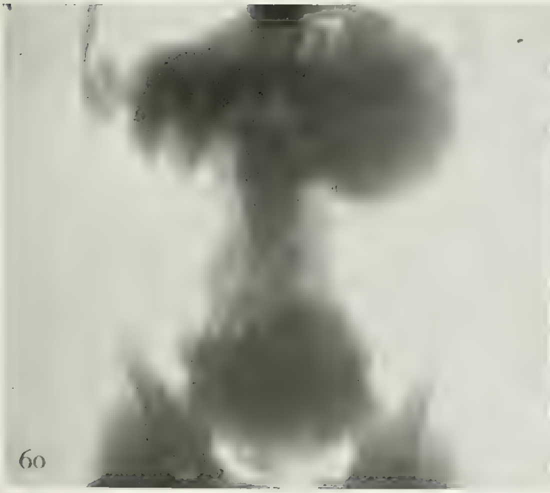
58

Fig. 58. Frontal view, horizontal position. Large cyst of spleen. Cyst of abdominal wall causing a dent in the anterior surface of the liver.



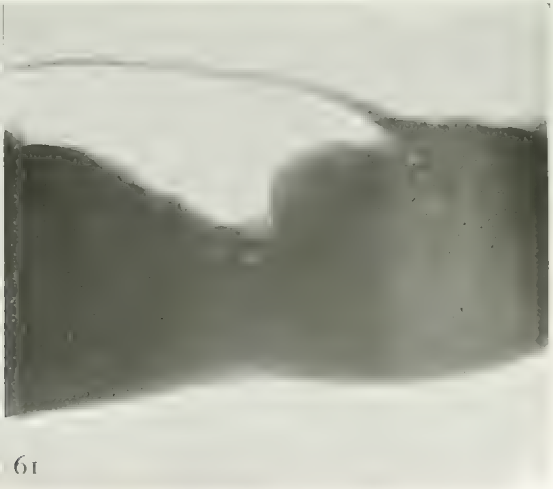
59

Fig. 59. Same patient in descending position, showing another cyst in the connective rectovesical tissue with four daughter cysts.



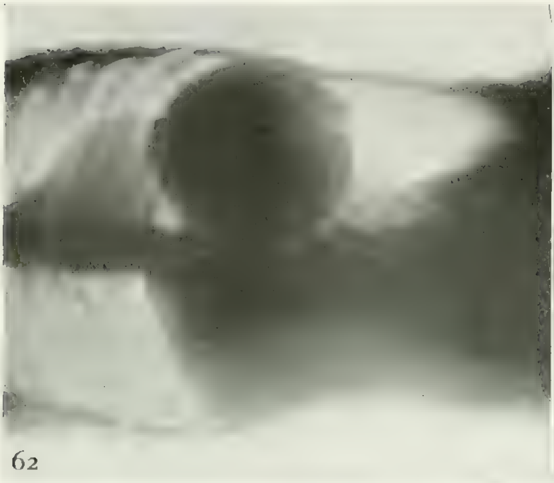
60

Fig. 60 Same patient. Showing clearly three of the above cysts.



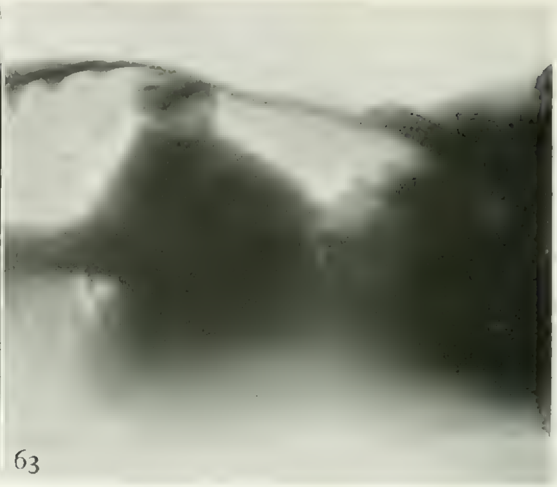
61

Fig. 61. Lateral view of same patient, descending position, showing outline of lower cyst in the peritoneal cavity.



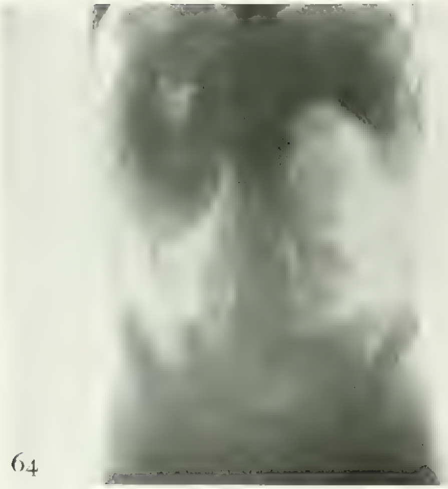
62

FIG. 62. Frontal view of same patient lying on right side. Adhesion of cyst to lateral abdominal wall clearly shown.



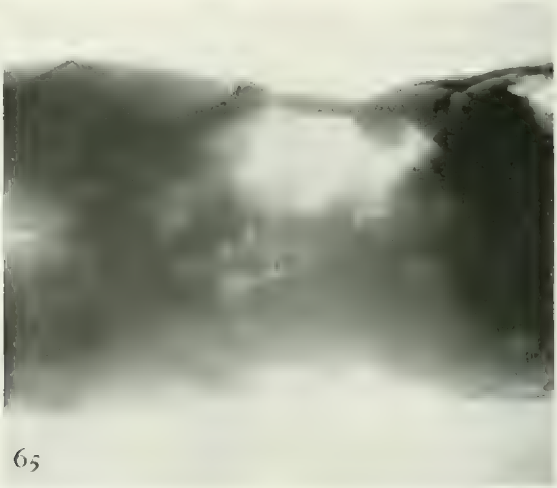
63

FIG. 63. Same patient lying on left side. It would have been impossible to make the diagnosis clinically or by a surgical examination.



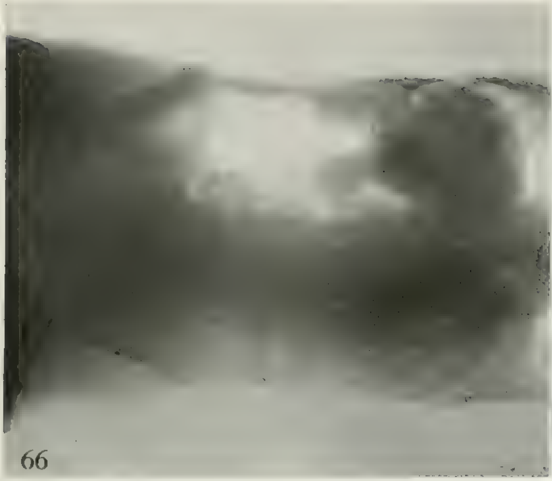
64

FIG. 64. Multiple echinococcus cysts of liver, of spleen, abdominal wall and pelvis. Patient operated upon on three occasions. Dr. Finochietto removed 21 cysts.



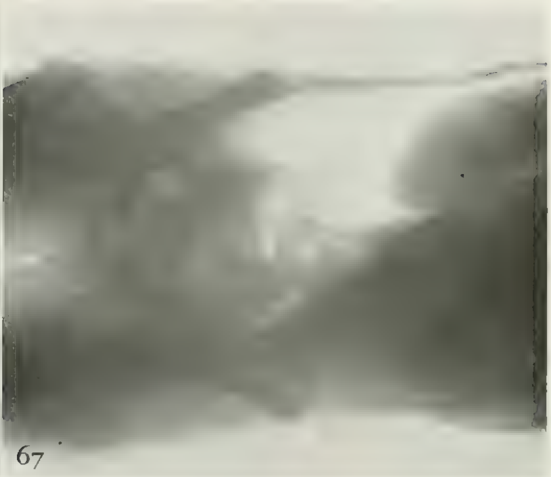
65

FIG. 65. Frontal view of same patient, descending position. Shows the cysts of the abdominal wall near the liver, a pediculated cyst, and several cysts in the pelvis.



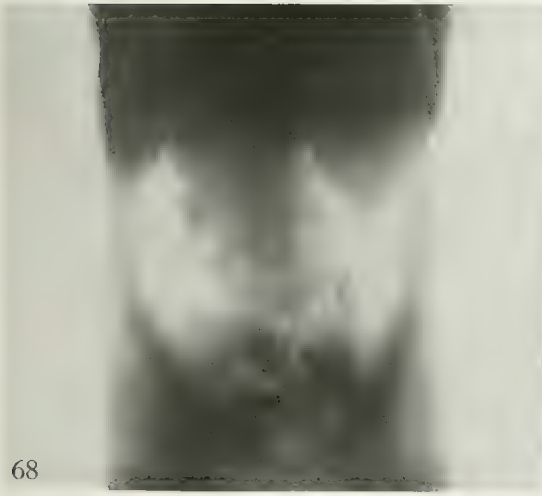
66

Fig. 66. Shows multiple cysts of liver and abdominal wall.



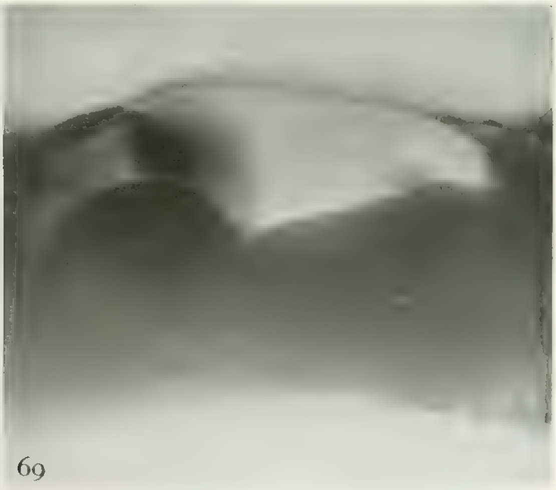
67

Fig. 67. Frontal view. Patient lying on right side, descending position. Shows cysts of the pelvis.



68

Fig. 68. Frontal view. Patient lying on abdomen. Shows cysts of the pelvis. Outlines rather confused on account of number.



69

Fig. 69. Ovarian cyst in a woman six months pregnant.

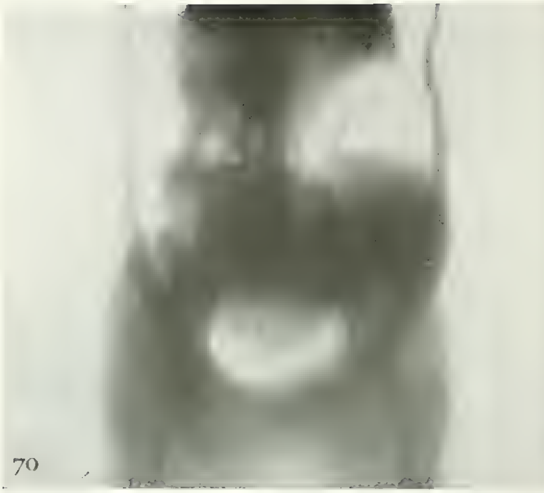

70

Fig. 70. Frontal view of same patient. Shows pregnant uterus and the cyst on right side.

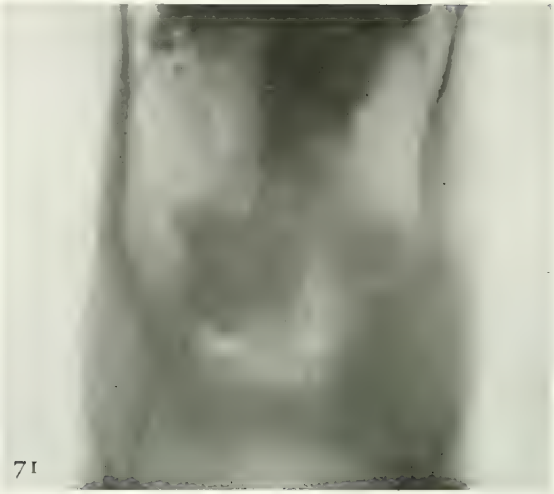

71

Fig. 71. Fibroid of uterus. Frontal view, descending position.

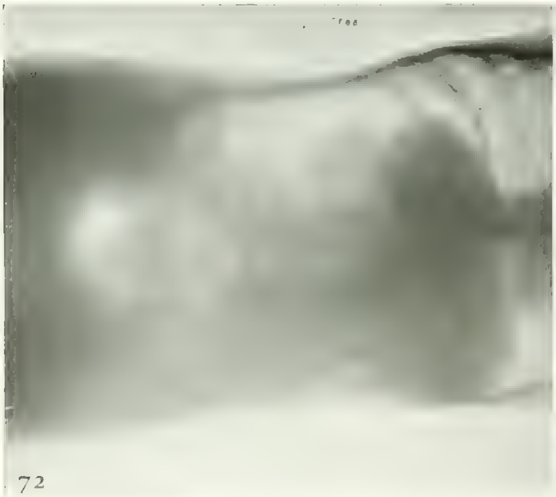

72

Fig. 72. Frontal view. Patient lying on left side. A round shadow is seen, representing a cyst of the left ovary with a long pedicle.

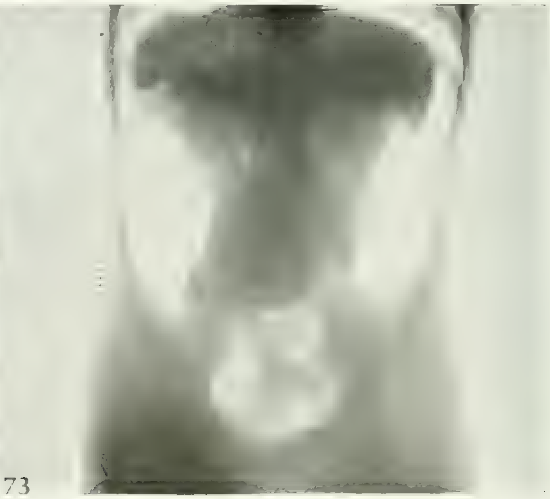
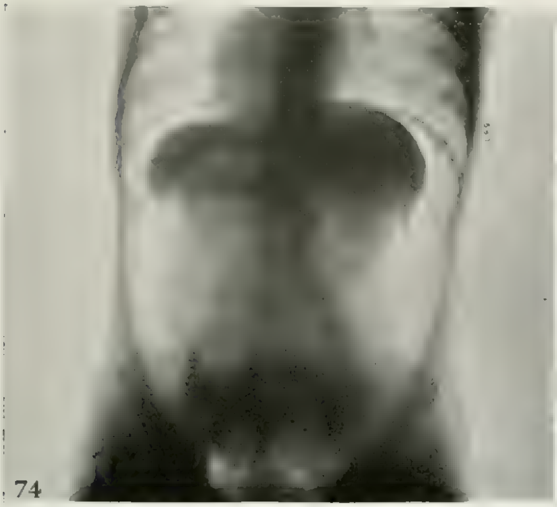

73

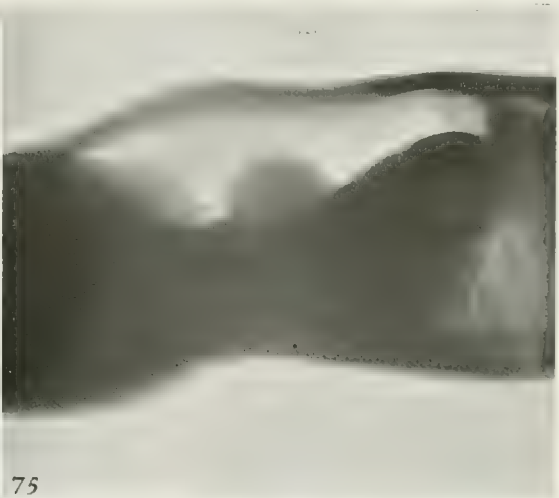
Fig. 73. Same patient, descending position. Shows the cyst with its pedicle.

is put on a watery diet. On the third morning, having completely emptied the intestines and bladder, and still fasting, he is ready for the pneumoperitoneum to be performed.



74

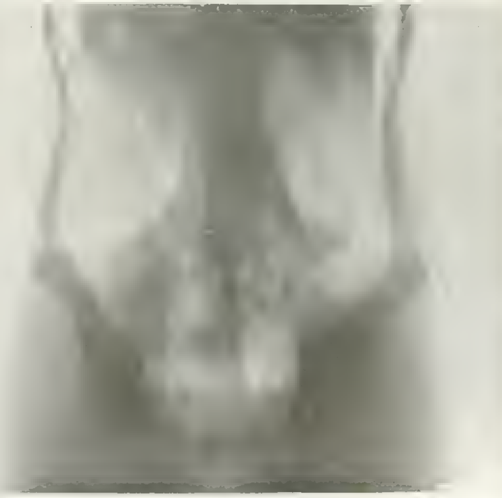
Fig. 74. Same patient, horizontal position. Shows cyst of left ovary, uterus, normal right ovary, liver, gallbladder, pancreas, etc.



75

Fig. 75. Lateral view, descending position. Snows outline of cyst and its pedicle in the peritoneal cavity.

2. *Method of Performing the Pneumoperitoneum.* In order to introduce the needle, the point of the abdomen which I select for puncture is situated at one or two fingerbreadths below the navel on the linea alba; but if a scar exists made by a previous operation, the abdomen can be punctured at any other point, it being in conformity with the rules of asepsis. A long and thin platinum needle is introduced into the abdomen. Having ascertained that blood does not flow, the needle is connected with a tube which brings the oxygen through the apparatus shown in Figure 1, and this is passed in rather slowly. According to the flaccidity of the abdominal walls after the introduction of 300 to 800 cm. of oxygen, the oscillations produced by the respiratory movement can be seen in the manometer of the apparatus. Once having clearly seen these oscillations, I continue injecting oxygen until the distention is considered enough. The volume of oxygen introduced varies from 2 to 8 liters according to the size of the patient's abdomen, the flaccidity of the walls, etc. This accomplished, the patient is in condition to be examined roentgenologically, and I should like to emphasize strongly the fact that he must not be allowed to make active movements by himself—that these must be made with the apparatus which we will describe later. Having concluded the roentgenological examination of the patient, the oxygen must be withdrawn. In order to do this, I introduce through the first puncture a trocar made of platinum with a silver sheath, the diameter of which is



76

Fig. 76. Small cyst of left ovary; hydrosalpinx of right Fallopian tube.

Fig 77. Normal kidney with its suprarenal gland.

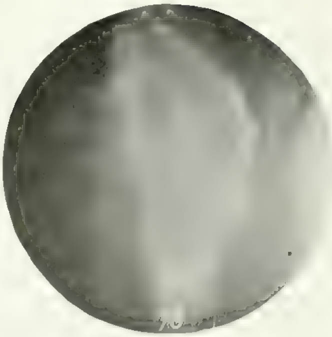


Fig. 78. The same.

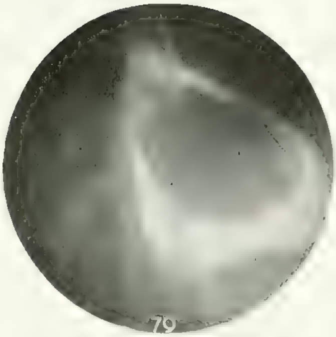


Fig. 79. Rotated kidney. Longitudinal axis of the kidney perpendicular to longitudinal axis of body.

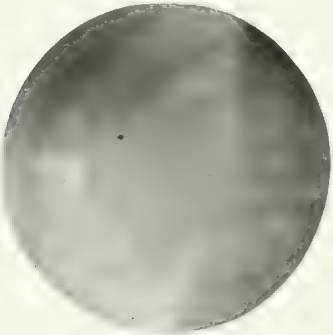


Fig. 80. Small stones in ureteric pelvis.

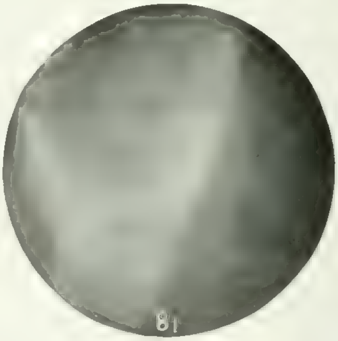


Fig. 81. Pyonephrosis calculosa.

Fig. 82. A stone in the renal pelvis, not visible in ordinary roentgenograms. Perinephritis in the superior half of the kidney; hence, outline of kidney is not visible in all its contour.

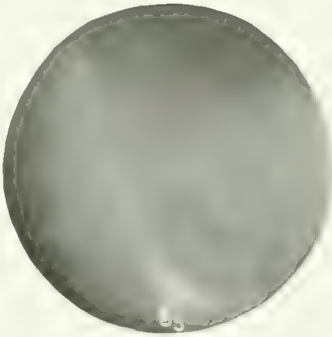


Fig. 83. Stones in the kidney.

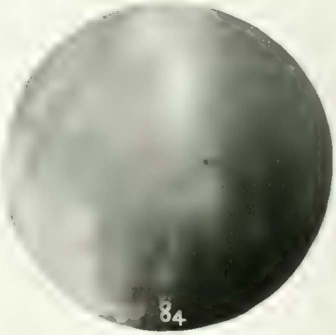


Fig. 84. Tuberculous kidney.

2.3 mm. The trocar has two lateral holes to allow the oxygen to pass out, and it can be assisted by lateral pressure on the abdomen. With the use of this technique, my patients get down from the table unaided and without complaint.

3. *Table Employed.* The table is seen in Figures 2, 3, 4, 5, 6 and 7. It consists of a platform which is constructed on a revolving base which can be balanced like a see-saw by means of gear; and this movement gives the necessary ascending and descending positions to the patient. This platform has a vertical pole at each corner. These poles are united by a frame at the top, upon which the tube slides backward and forward. From this same frame is suspended by means of two pulleys, one at each end, a hexagonal steel bar, which can be raised and lowered by means of a handle. Before performing the pneumoperitoneum, the operator places a sash or girdle under the patient, and when the operation is finished, the two ends of this girdle are attached over the hexagonal bar which has been sufficiently lowered for this purpose. The patient is thus suspended in a kind of hammock and can be turned in any desired position.

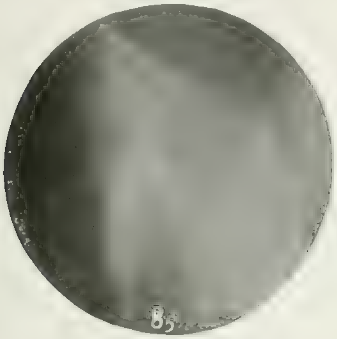


Fig. 85. The other kidney (normal) of same patient (Fig. 84).

Fig. 86. Tuberculous kidney.

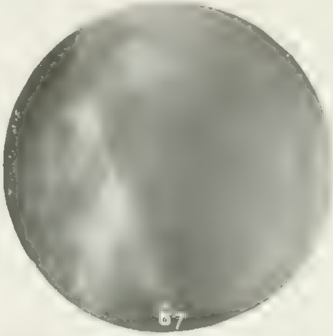


Fig. 87. Sarcoma of the kidney.

We have seen that the pneumoperitoneal process enables us to explore all the solid organs contained in the peritoneal cavity. It should be remembered that the kidney, anatomically speaking, is situated outside this cavity, and for this reason the pneumoperitoneal process does not allow of its exploration with the same clarity as in the case of the liver or spleen.

I have therefore endeavored by means of an indirect procedure to create physical conditions around the kidney analogous to those of the organs included in the peritoneal cavity. To this end, it sufficed to create artificial emphysema in the perinephric fatty and cellular tissue of the kidney. The procedure was as follows:

After having taken a first roentgenogram with metal guiding points on the patient's skin, one fixes on the point which corresponds to the transverse process of the second lumbar vertebra.

A fine platinum needle, 10 to 12 cm. in length, is introduced down to this process (of course, according to the rules of asepsis).

As soon as this process is encountered, the needle is made to deviate so as to avoid it, while watching the manometer of the injecting apparatus, and as soon as the manometer shows oscillations, one knows for certain that the needle has entered the perinephric cellular tissue.

One then commences to inject the gas which is to produce the artificial emphysema.

This injection is made either with a Forlanini apparatus or the *Oxygénateur de Précision du Docteur Bayeux.* I used to employ carbonic dioxide, but I found that the absorption was so rapid that it did not allow sufficient time for taking several plates. For this reason I now use oxygen instead of carbonic dioxide.

This operation is not painful. The patients experience a certain amount of discomfort in the lumbar region, but that ceases within an hour.

The quantity of oxygen one injects varies from 200 to 600 c.c., according to the size of the patient.

REPORT OF A CASE OF SO-CALLED "MARBLE BONES" WITH A REVIEW OF THE LITERATURE AND A TRANSLATION OF AN ARTICLE*

BY WILLIAM G. ALEXANDER, M.D.

Evanston Hospital

EVANSTON, ILLINOIS

ON May 18, 1921, a patient was brought into the Evanston Hospital with a fracture of the right hip produced by a simple twist while engaged in her home duties. The roentgenogram was so remarkable that a diagnosis of the cause of the fragility of the bone was not made at first, and a tentative diagnosis of "fragilitas ossium" was made. It was felt that this was an improper one, but no one of the staff had ever observed such a condition, and no one else seemed able to give any help in the matter. It was simply left at the time until further observation could be made. In November, 1921, there appeared in the *Archiv für klinische Chirurgie* an article by Fritz Schulze[1] in which he reported a summary of all the cases he could find in the German literature (6 in number) of what he called *Marmorknochen*, explaining that this term was in no sense a proper diagnostic title, but a term that would express the peculiar appearance seen in the roentgenograms of the bones. It was immediately realized that this was the condition seen in our patient, and an effort has been made to make a more complete examination of the patient and to give a report after one year of observation.

In reporting this case, it has been my intention to consider it from the *x*-ray aspect rather than from the operative, although I have tried to give all the essential points in the history.

Female, aged forty-three years. Married. Five children, all living and well. One miscarriage. Patient belongs to the fourth generation of parents on mother's side who were cousins: i.e., her mother and father were cousins, married in America. This mother's mother and father were cousins, married in Germany. This grandmother's mother and father were cousins, married in Germany. The patient was born in America. No unusual physical condition can be located by the patient in any other member of the family. She was one of seven children, four dying from children's diseases in the first five years of life. One brother died from pneumonia. One brother is living and well. Her father died from pneumonia, cause of death of the mother being unknown. The patient is the youngest of the seven.

Patient has had the following illnesses:

1. A nervous break-down fourteen years ago. (Nature of this does not seem unusual.)

2. Typhoid fourteen years ago.

3. Had a simple fall twelve years ago resulting in a fracture of the left hip. This was cared for by an attempt at nailing. At the present time the roentgenogram shows the nail sheared into two parts. Just when this occurred cannot be determined. The operator, Dr. Chas. E. Kahlke of Chicago, makes the statement that it was almost impossible to drill the hole for the nail and that the operation was very difficult. After about two years the patient was able to hobble about on crutches and had done so up to the time of the present accident.

4. Influenza in 1918.

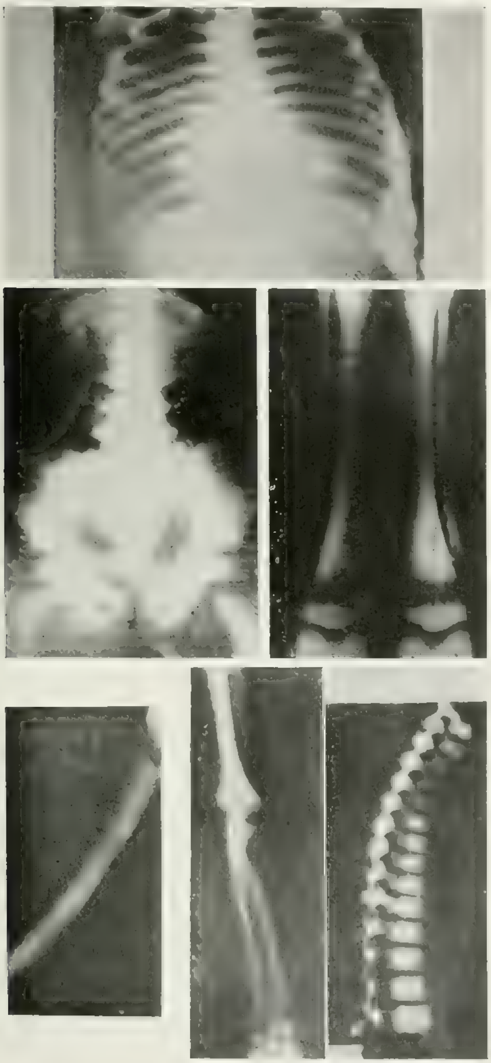
5. Complained of "rheumatism" for many years (possibly due to the bone changes).

6. Claims that she had a fracture of the left humerus about five years ago, but roentgenogram does not show any change of that nature.

Present condition followed a slight twist while placing some clothes in a closet, when she felt the right hip give way. Has suffered much pain and complete disability since the fall. Was admitted to the hospital under the influence of morphine and placed on the surgical service. An examination showed the following facts: Patient is very anemic, with a peculiar lemon tint to the skin. The eyes react sluggishly to light and accommodation, due to the morphine. The teeth are bad. There are no unusual glandular enlargements. The chest shows no unusual findings. There is a soft systolic blow heard at the apex of the heart. The abdomen is negative. Examination of the lower extremities shows limited motion of the left hip. The right hip is very painful on any manipulation and shows evidence of fracture. Slight right facial paralysis and difficulty of speech.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion on this paper and others in the same symposium will appear in a later number of the JOURNAL.



FIGS. 1–5. These figures are photographic reproductions from the article by Schulze and show the high degree of calcification present.

Laboratory examinations show the following findings:

Urine. A slight trace of albumin, otherwise negative.

Blood. Hemoglobin 45 per cent, 2,940,000 red cells, 4,500 white cells.

Wassermann Reaction. Clearly negative.

Differential Count. Polynuclears 84 per cent; large mononuclears 8 per cent; small mononuclears 6 per cent; transitional 1 per cent. A slight amount of poikilocytosis and a few macrocytes. The blood group is type IV.

Under transfusion of 500 c.c. of citrated blood and proper medication, the blood rose to 52 per cent—3,600,000 red cells, 4,500 white cells.

Reduction of the fracture was attempted under the fluoroscope, with poor success, and it was decided not to make any effort at nail fixation, but simply to try to maintain position for a long time, and allow the joint to give the best result it would. Examination made May 18, 1922 (one year after the accident), showed really about as good result as did the original operation on the other hip. There is, apparently, a false joint on each side with some range of motion and not the slightest sign of callous formation. The edges of the fractured ends are very sharp.

Summary of the findings at the second examination made May 18, 1922, just one year after the accident to the right hip and thirteen years after the accident involving the left hip: Hemoglobin 50 per cent; red cells 3,140,000; white cells 5,050.

Stained smear shows considerable poikilocytosis, with a good many oversized red cells, but not sufficient change to warrant any idea of anything more than a simple anemia.

Films of the hips and pelvic girdle show about the same condition as at the examination one year ago, as regards the highly opaque construction of the bone. It is absolutely free from any truss-work and appears to be absolutely solid marble. Even the coccyx is completely calcified.

The right hip shows no change over one year ago. The left hip shows no evidence of callus, but there is apparently a false joint formed at the point of fracture, and there is some power of motion, as shown by the ability of the patient to flex the thigh to a slight extent. It was considered worth while to examine the other regions of the body, and films were taken of the head, chest, lumbar and dorsal spine, region of the elbow, the tibia and hands, in addition to the stereo film of the pelvis. All these areas show the characteristic changes, with the least change shown in the hands, where there are seen small isolated areas of calcification. The clavicles seem to be also less involved than the other bones of the shoulder girdle.

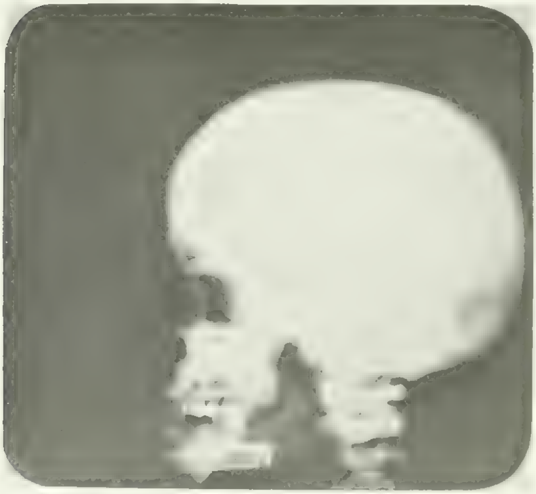


Fig. 6. Lateral view of the skull showing the great density of the bone. It is impossible to reproduce the fine detail. The sphenoid sinus and the cell structure of the mastoids are practically obliterated.

The skull shows a general change of marked increase in lime salts, but the base of the skull seems to be most affected. The sphenoid bone appears intensely involved; in fact, the sphenoidal sinus seems to be obliterated. The sella turcica is smaller and more completely enclosed than normal. The temporal bones seem much changed, and there is no definite cell structure to the mastoids. The skull thickness is increased over the normal. The bones of the face show irregular changes, not so uniformly as the head bones. There is much trouble with the teeth and jaws.

The spine shows, throughout, extreme changes in the bones, but the cartilages seem unchanged. Clinically, we find no marked stiffness in any of the joints, even the spine. The process has affected in a uniform manner the whole of each vertebra, bodies and processes alike. There is no clinical evidence that the vertebral canal has been encroached upon at any point, and the edges of the bodies are remarkably free from any arthritic roughness. As stated above, the sacrum and even the coccyx are thoroughly marbleized. The sacroiliac joints are clearly differentiated, and, while rather narrow, show no actual deformity.

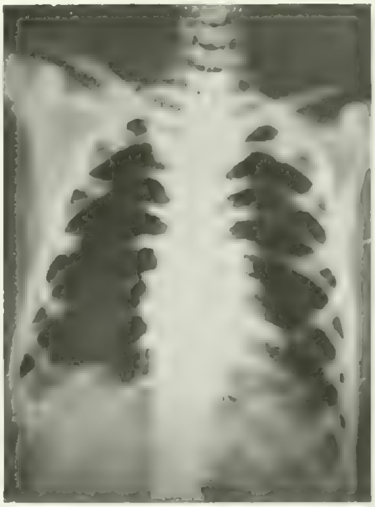


Fig. 7. The bones of the chest show the even dense shadow, with the exception of the clavicles, which are less affected.

A film of the chest shows the same uniform changes in the bones of the shoulder girdle except the clavicles, which seem to have escaped the extreme process, but show some increase in lime content. The ribs are very dense, but the cartilages show no more change than is seen in many cases of senile change from tuberculosis and other wasting diseases. While the film was not taken for the lung tissue, yet one feels that no definite change can be seen. The patient could not lie on the face, so that no film showing the sternum was taken.

The bones of the upper extremities show less change than the other bones of the body. We find the changes in the humerus show a definite line of demarcation at about its middle. Above this point all trace of the medullary canal is lost, but below, there is a fairly definite shadow of the medullary canal, and at the elbow the cancellous structure is fairly normal. The shadow is simply a little more dense than the normal. Although the patient gives a history of a fracture of the left humerus several years ago, no *x*-ray evidence has remained of such a condition. There is no callus that can be seen. The bones of the hands show isolated areas of higher lime content than the general structure, but none of the bones show the general density seen elsewhere.

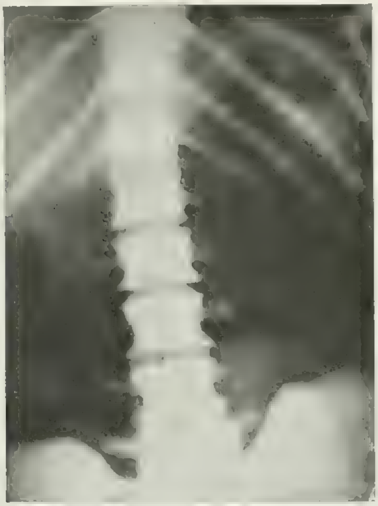


Fig. 8. The vertebræ are of even density, but the cartilages do not seem to be affected. There is fair mobility between the vertebræ.

In studying the femora more in detail, one is struck at once by the fact that no apparent callus has formed at the fracture of twelve years ago. At least, the lines of the old fracture are clearly seen. There has been no "wiping" of the joint, a process usually done by nature. In the films taken of the recent fracture after one year of rest, the fracture borders seem as sharp as ever, although the bones are not as widely separated as a year ago. I am of the belief that no real bony union has occurred. The film of one year ago was taken through a plaster cast, while no splint of any kind was present at the later one. This may account, in part at least, for the slight reduction in density of the heads of the femora, or it may be due to the non-use in walking. The high degree of calcification extends throughout the shaft of each femur without any evidence of definite medullary canal.

A careful review of the literature in the English language shows, so far as I can find, not a single case reported, and the only references to the possibility of such a condition, in general books on medicine, surgery and pathology, are given under the heading of "Osteosclerosis," where the statement is made in 2 cases that the process may involve all the bones, from causes unknown.

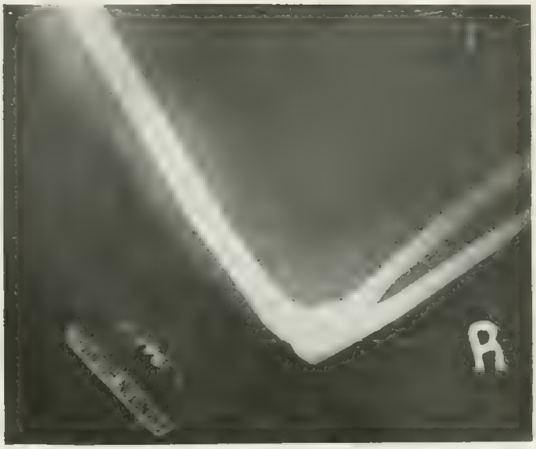


Fig. 9. The bones of the forearm are much denser than the normal, but near the elbow some structure can be seen. The patient reported that a fracture had previously occurred in the right humerus, but no evidence could be found of the fact.

The article by Schulze reviews all the cases he could find in the German language, and I am including portions of it at this point. I have felt that it would be worth while to incorporate the translation of the entire article because of its completeness in reporting the cases, because of the rarity of the condition, and since the article is not generally obtainable; but I have summarized most of his discussions, and have endeavored to give an accurate translation, although relatively free, at the same time giving the case records nearly verbatim. A bibliography at the end of this paper includes the sources of the reports referred to in the article by Schulze as well as some other recent articles on allied diseases (osteosclerosis, rickets, osteomalacia, fragilitas ossium, metastatic bone tumors, etc.).

The article by Schulze is entitled, "The Nature of the Picture in the Illness known as Marble Bones." It is as follows:

In 1904 Albers-Schönberg[2] called attention to an unusual change in the skeleton whose peculiar findings he demonstrated roentgenologically to be: (1) that everywhere the structural contour of the bones was preserved; (2) that the medullary canal and the spongy portions were changed to compact bone substance; (3) that, in all probability through this change, the lime content of the bones is extraordinarily increased.

These changes which give the bones the "marble-like" appearance produced uniform changes in the entire skeleton in the case studied by him and were clinically significant in that the bones showed unusual fragility, so that proportionately insignificant accidents gave rise to various fractures.

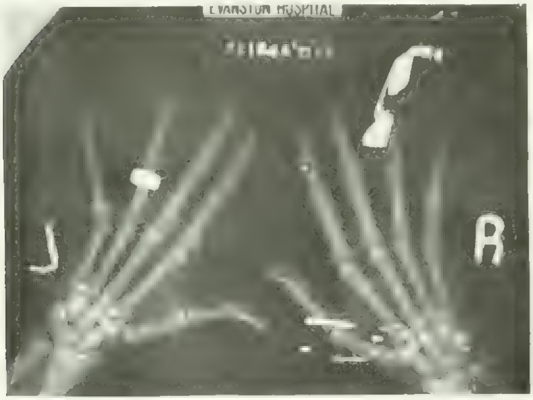


Fig. 10. The bones of the hands show isolated areas of the increased calcification, but the remarkable feature is the peculiar striation of the metacarpals and the phalanges and the central foci in the carpals.

In his second communication, in the year 1907, Albers-Schönberg added to this summary of his patient who had enjoyed the best of health for twenty-six years and had followed his business of merchant. The findings in the first examination were unchanged. The apparent absorption of the skull was present with retention of the great density in the neighborhood of the sella turcica. The posterior clinoidal process appeared like a sickle-shaped prominence because of which the sella turcica was apparently narrowed. Also the crista galli showed the same changes.

The thickness of the skull had not changed from the normal. The spaces for the vessels and the sutures were clearly differentiated, but, on the other hand, the entire skull showed the same marble character as the rest of the bones of the skeleton. In this report Albers-Schönberg emphasizes the marble changes of the bones as especially characteristic in the diaphysis of the bones of the feet, hands, fibulae and the ribs, where there are seen parallel lines of lime deposits. He considered these changes as all due to very heavy lime deposits.

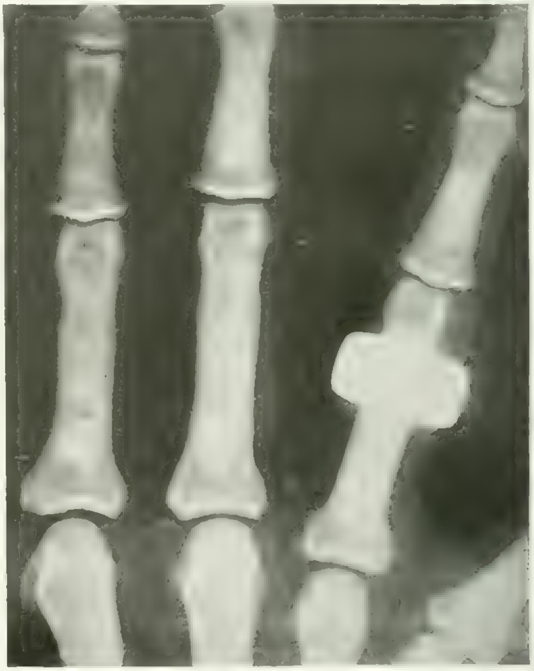


Fig. 11. This is a print taken directly from the original film and shows the peculiar transverse lines of calcification and the smooth articular surfaces. Note that the density of the bone in certain of the areas involved is almost as great as that of the gold ring.

Etiologically, the condition remained entirely unexplained.

In 1914, followed 3 other cases reported by Sick:[3]

Case I. A fifteen-year-old girl rather

underdeveloped, nominally well in early life, who suffered a fractured femur at the fifth year of life through an insignificant accident. In the course of the fourteenth year there were other broken bones; in the course of the last two years there appeared a suppurative process of the lower jaw with loss of all the teeth. Ophthalmoscopically there was considerable optic nerve atrophy.

Heart and lungs were normal. Wassermann negative. Roentgen examination showed entirely structureless skull bones. The sella turcica was narrowed and closed. The clinoid process was very prominent. Vertebrae and ribs showed no particular changes, but appeared, as in metastatic carcinomata of the bones, secondary to prostatic carcinoma. The pelvis showed a uniform even color without structure. The femurs showed, aside from the marked bowing of the neck and the changes in the region of the trochanter due to the many fractures, club-shaped thickening, especially at the knee-joints; likewise the tibia and the fibula showed in the regions of the knee the same definite knobby thickening. In the lower half of the tibia, parallel lines are seen in the diaphysis. The epiphyseal lines are preserved.

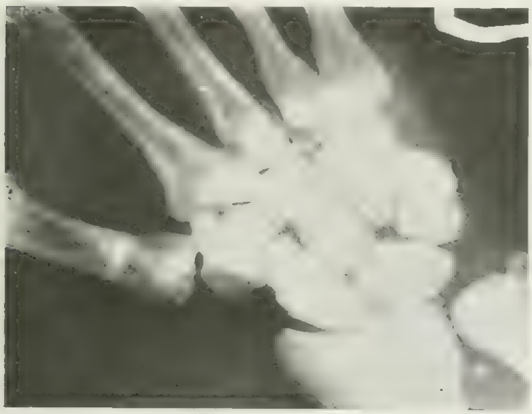


Fig. 12. The metacarpals show the marked increase in density at their bases and the carpals are very dense. They differ slightly from the description given by Schulze in that there is no almond-shaped center.

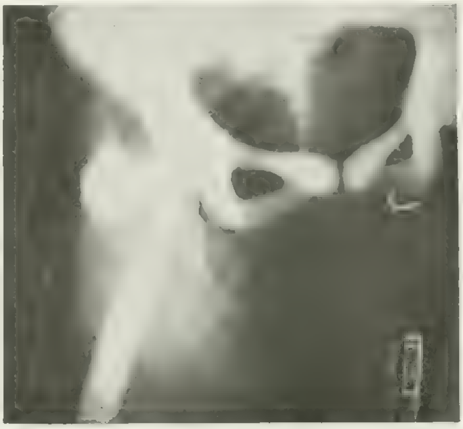


Fig. 13. This film was made at the time of the second fracture and was taken through a plaster cast. It shows the position of the parts.

The epiphysis proper shows, like the diaphysis, a completely structureless form, and only in the lower third of the leg can the distinction of the cortex and medullary canal be demonstrated. In the other extremities are seen several healed fractures with deformity. In the upper half of the humerus is seen the knobby thickening, while the lower half shows fine striations running toward the concavity of the diaphysis.

Case II. A three-and-a-half-year-old boy with hydrocephalus, marked reduction of sight and early atrophy of the optic nerve. In the skull is seen a marked thickening of the posterior clinoid process so great that the hypophysis appears to be in a narrow lock. The base of the skull and the bones of the face are very thick and structureless. The humerus is club-shaped at the upper end, and the diaphysis shows in the neighborhood of the epiphysis a very shadowy thickening which is especially definite in the lower radial epiphysis. The bones of the hand show the normal construction in the appearance of the centers of ossification at the wrist.

The metacarpals and phalanges present a remarkable picture. In the metacarpals the bone in the neighborhood of the epiphysis shows marked thickening and gives a dark shadow, which is seen at the proximal ends of the 2nd to 5th metacarpal as well as the bones which do not show any epiphysis, and the phalanges show a marked thickening in the proximal ends of the diaphysis. On the inner half of the diaphysis the bone appears in the roentgenogram in long dark lines. The femurs show club-shaped thickening and lack of structure in the epiphysis of the adjoining portions of the bones. Remarkable is the picture of the bones of the feet. Astragalus, calcaneus and cuboid show peripheral shadows with thickening again in the centers with clear areas between.

Case III. A two-and-a-half-year-old girl with hydrocephalus and optic atrophy. In the skull the sella turcica is narrowed but not so pronounced as in Case II. The posterior clinoidal process is markedly enlarged. The skull bones show the same even structureless form as the other case and the bones of the extremities do not vary from the description already given.

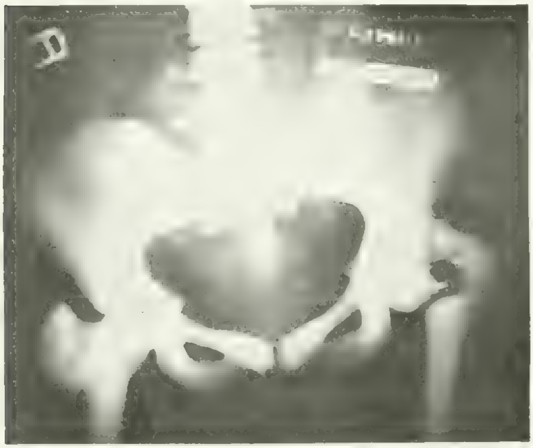


Fig. 14. This film was taken one year after the second fracture and shows the first fracture after about thirteen years. Note the sheared-off nail used at the time of the first fracture. Note the absence of apparent callus. In this respect, the case differs from those of the children reported by Schulze, possibly due to the age of the patient.

Sick concluded from his investigations, which differed from the case of Albers-Schönberg in that the circumstances gave him growing bones to study, that especially the diaphysis, and indeed the neighboring epiphysis, showed a distinct thickening—and he concluded from this that *there* were located the early stages of this unknown disease process. He positively determined that the epiphyses where they were examined had shown a uniform structureless nucleus; the fine parallel lines in the diaphysis he considered as zones of growth.

Cases II and III of Sick's investigations were sisters and the other one was a blood relative. They were, like that one, backward in their body growth while they showed no definite mental defects.

From a communication by Lorey[4] we learn that these three children died with signs of anemia and that Nos. II and III developed necrosis of the lower jaw bone with discharging fistulas. At the same time, Lorey reported concerning a brother of the two sisters, on whom at the age of three weeks he could show the same uniform thickening of the skeletal system, so that even by long exposures the roentgenogram could show no distinction between cortex and spongiosa. Especially remarkable was the uniform change in the calcaneus and the astragalus which showed no reduction in density in the center, as had been true in the two sisters. The transverse bands could not be discerned here.

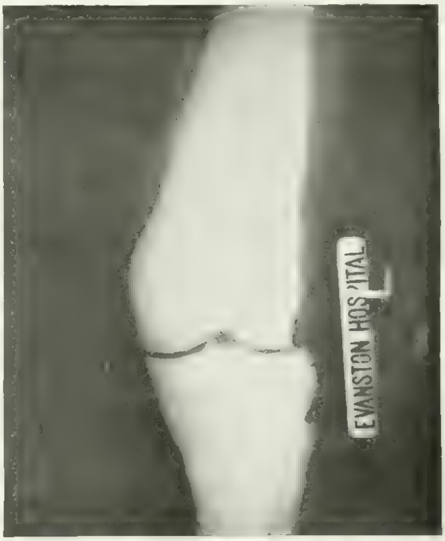


Fig. 15. The knee shows some clubbing, referred to by Schulze, and there is a complete absence of any structure in any of the bones forming the joint. A lateral view shows, however, that the patella is but slightly affected.

The bones of the extremities were very highly and uniformly thickened. Only at the proximal ends of the phalanges were the appearances of transverse bands. There was increased spinal pressure in the child, and, in a few weeks, blindness followed optic atrophy.

The child died at the age of five months after developing a high grade anemia, and a necrosis of the lower jaw, with draining fistulas.

Autopsy was denied in all these cases.

Concerning Albers-Schönberg's patient we hear again eleven years after the first communication through a report by Reiche.[5] From it we learn that the patient, in the interim, had received, from slipping in his room, a fracture of the thigh which healed in five weeks. We find from his history that the man, now more than thirty-seven years of age, has shown a reduced mentality and has acquired a very pale complexion. Has had a childless marriage. His appetite has become increasingly strong. He requires much sleep. Intercurrent illnesses leave him each time with an unaccountable weakness. The new roentgenograms still show the concentration of the bone substances already described. Objectively the whole clinical picture has not changed. Heart, lungs and nervous system are as before. The lymphatics in the supraclavicula region, axillary, inguinal and the right femoral region are in small white bundles. In the left groin is a white, tender, soft lump about the size of a child's fist. The liver extended about 1½ fingerbreadths below the border of the ribs. The spleen, when brought down by deep inspiration, showed about the breadth of the hand, was large and firm and had a rounded edge.

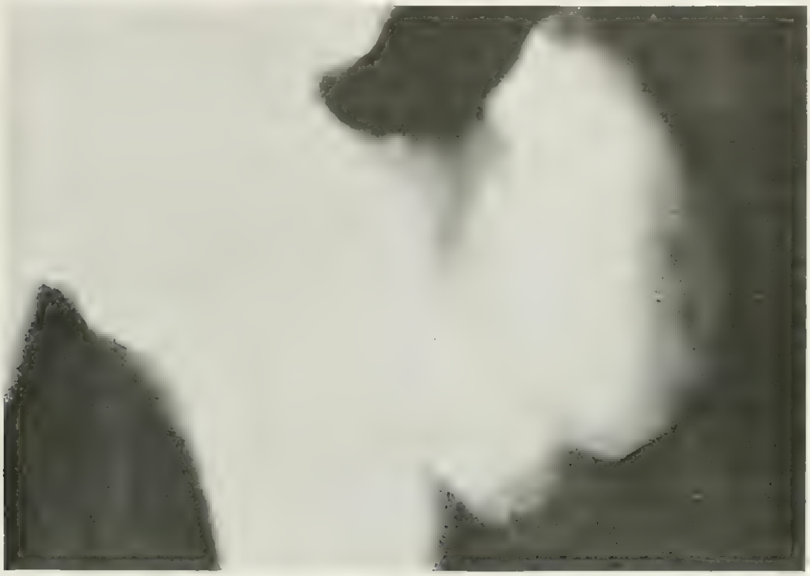


FIG. 16. A direct print taken to show the lack of callous formation after one year from the date of fracture. Practically no detail of the bone can be observed.

From the history by Albers-Schönberg there appeared a very definite luetic heredity, on the basis of which Reiche had instituted an intensive anti-luetic treatment meantime, without result and with no change in the changed bones. Through the elaborate investigation, it seems, then, that the changes occur in the earliest childhood.

Laurell and Wallgren[6] report a sixth case of this unusual disease. It occurred with a twelve-year-old boy from a healthy family, who developed poorly and was able to sit alone first at the age of one year. Soon after birth there developed a hydrocephalus and nystagmus, and in his second year, difficulties of vision. Only at two and a half years was this boy able to walk without help. In his third year his case was diagnosed by a physician as hydrocephalus and English disease (rickets). At the age of eight there occurred a fracture of the right leg, which healed in eight weeks, followed in one year by another fracture of the same leg. At eleven years a fracture of the right thigh occurred which united in six weeks. After another year a fracture of the upper part of the right thigh occurred. The occasions for these fractures were in every case insignificant. From the *x*-ray examination, as well as the history, there was evidence of fractures other than those enumerated.

The mental development of the boy is quite good. The musculature is very poorly developed, as is the fatty tissue. The development of the skeleton is delayed. The teeth are very carious. The chest is deformed by an indrawing of the diaphragmatic area and a corresponding outward bending of the border of the sternum. A rachitic rosary is not demonstrable. Skin and tendon reflexes are active. There is bilateral choked disc in an atrophic stage. There is lateral nystagmus. Hydrocephalus is present. Lumbar puncture showed a pressure of 330. Lungs and heart are normal. Spleen is palpable under the edge of the ribs. Liver not noticeably enlarged. In the axilla and the inguinal region are lymphatic nodes of the size of peas to beans. The sexual organs correspond to those of an adult. The cartilagenous rings of the trachea, from the thyroid cartilage on, are free from gland tissue. The thyroid gland is not palpable. Wassermann is negative. Blood picture is that of secondary anemia with 80 per cent hemaglobin.

Aside from the signs of the old fractures, the *x*-ray examination shows an abnormally high lime deposit as well in the bones of the skull as the bones of the extremities and trunk. These changes are especially remarkable in the upper portion of the femur. Here we see the diaphysis and metaphysis for the most part a homogeneous dense appearance without differentiation of the cortex, spongiosa or the medullary canal. Especially impressive is the appearance of the encircling bands of lime salts parallel to the epiphysis. They are found in the long bones and the flat bones alike; for example, the concave portion of the sacrum. The definite enlargement of the skull shows everywhere the changes seen in the other cases. The sella turcica is remarkably small and has a narrow, canal-like entrance. The vault of the cranium is stronger than normal in the posterior part and somewhat thickened, and the diploë appear about complete.

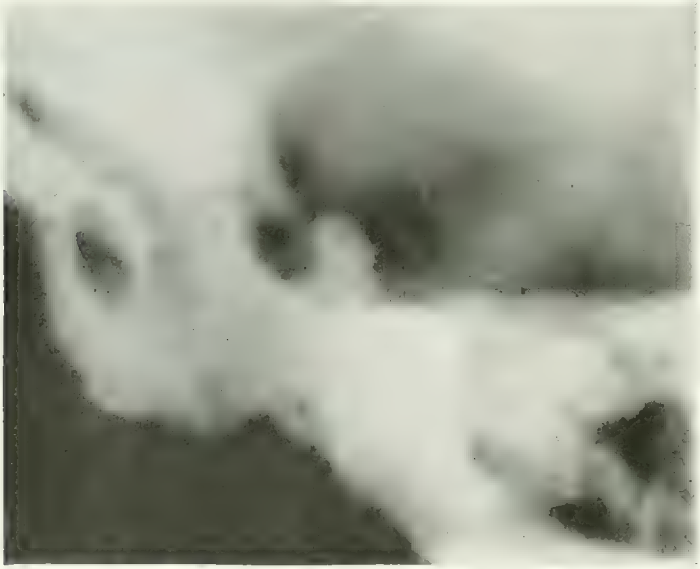


Fig. 17. A direct print from the original film to show the high calcification of the base of the skull and the narrowing of the outlet to the sella turcica. The even density of the bone makes it very difficult to demonstrate the details.

Both bones of the upper arm are clubbed in the upper third. The same appearance shows in the distal ends of the femur and the proximal ends of the tibia. Both sides show a coxa vara position. Astragalus and calcaneus show the almond-shaped transparent areas in their centers that have already been described by Sick, as do also the navicular, cuneiform, and cuboid bones. Very pronounced is the appearance of the bands of lime deposits in the metatarsals, the metacarpals, and phalanges of the hands.

While Albers-Schönberg, Sick and Lorey, in common, limit themselves to the discussion of the roentgen and clinical findings and fail to name a place for the malady from their investigation, Reiche believes that he is able to harmonize the unusual findings in the bones with those pictures of common osteosclerosis as they were described by Neuman, combined with leukemia, and by v. Baumgarten, with pseudoleukemia.

Guided by the conception that such extended damage to the bone-marrow as would follow an osteosclerotic process would give cause to noticeable changes in the blood picture, Reiche has continued his observations of Albers-Schönberg's patient since November, 1907.

The blood showed a watery pink color. The coagulation time was rapid. The hemoglobin was much reduced and varied between 30 per cent and 36 per cent. In the microscopic picture, there appear in the red cells definite gross changes similar to the changes in poikilocytosis, and the hemoglobin shows irregular distribution in the blood discs. Polychromasia is frequent. The red cells were crenated in many preparations. The various types of erythroblasts were constantly present—micronormo- and macroblasts, and occasionally gigantoblasts of unusually large dimensions. Often were the nucleated red cells polychromatic, occasionally staining a dark violet blue. Blood platelets were always plentifully abundant. The count of the red corpuscles was about 2,000,000. The leucocyte count was about 6,400—in it the polynuclear count was lowered while the lymphocyte count was increased. Eosinophiles were normal.

The anemic condition of the blood in company with the enlargement of the liver, spleen and lymphatics moved Reiche to associate the bone changes as a composite disease and, in a sense, to locate them in the same group as the cases of myelogenous pseudoleukemia described by v. Baumgarten.

He left open the question of the possibility that the well-established blood changes always seem to be a result of the osteosclerosis. He was impressed with the similarity in the blood findings with those in osteoplastic carcinomata of the skeleton and in multiple myelomata.

Laurell and Wallgren, who, in their cases, established, at all events, only an essentially low grade of anemia, discuss the case only as similar to that of Reiche. They decide the blood changes to be of secondary character and they assume the enlargement of the spleen described by him as the expression of a vicarious entrance of its activity as the "result of reduction of the bone marrow."

Concerning the question of the hereditary luetic origin of the malady, Reiche was uncertain. It appears also that the antecedents of the case reported by Albers-Schönberg support such an uncertainty. It is very poorly supported by all the other cases, so that it would seem that such etiology may be dismissed from consideration.

Under the impression that the thyroid was not thoroughly established, Laurell and Wallgren have tested the sugar tolerance of their patients in proof of alimentary glycosuria as seen after adrenalin injections. The result that a higher tolerance appeared, strengthened the idea of a hypoplastic thyroid. They also, similarly to Sick and Lorey, assume as the cause of the delayed general development, the changes in the hypophysis (even a hypoplasia), and they come to the conclusion that, as an explanation of the general picture of this skeletal malady, there is possibly a pluriglandular affection of the endocrine glands which they see in the hypoplastic condition of the hypophysis and the thyroid.

We are fortunate in being able to further the knowledge of this research by another case of this rare and peculiar skeletal change in which we can add the autopsy report to the roentgen findings.

Hugo S., aged eleven years, descended

from a healthy family, without hereditary taint, mentally well developed, and usually well in earlier life. Recovered from scarlet fever in 1914. Since that time his health has failed. There has been indefinite pain in all the limbs. He was placed in a tuberculosis sanitarium, but with no improvement. In the course of the year there appeared a gradual stiffness of the spine and increasing pain in all the joints.

At the beginning of the observation he appeared as a large growing boy of 52 lbs. His features showed senile character. The face and visible mucous membranes were anemic. The subcutaneous fat was reduced everywhere, the musculature was atrophic, the skin thrown into folds.

The illness disabled him so that he could lift himself from bed only with outside help. The spine showed in the upper part a scoliosis and appeared stiff and immobile. The slender bones of the extremities showed no abnormality. The teeth were undoubtedly rachitic.

The ligaments of the patellae were thickened and gave the feeling of hard lime deposits in them. The same appearance was found in both Achilles tendons. Hard lime deposits of pea-size were seen in the skin of the neck.

Enlarged lymphatic glands were not determined.

The lungs showed by auscultation and percussion no changes from the normal, and especially every effort was made to exclude tuberculosis.

The liver extended one finger-breadth below the costal margin.

The pancreas was not palpable.

The patellar, cremasteric, and abdominal reflexes were slightly exaggerated. Otherwise the nervous system was normal.

The action of the heart was increased, the pulse ran 104 to the minute with strong epigastric pulsation. The heart border reached toward the left to the mammary line, while to the right it extended to the left border of the sternum. The tones of the heart were normal, with no murmurs. The second aortic sound was sharply accentuated. The pulse pressure was low. The radial artery was hard. The temporal artery was tortuous and hard and the same changes were present in the upper-arm vessels.

The urine had a sp. gr. of 1.005, contained red blood cells, no casts, no albumin.

The picture is completed by the most remarkable roentgenograms. Aside from the calcification of the patellar and Achilles tendons already determined by clinical means, we find in the *x*-ray plates undoubted periarticular calcification of the hip and knee-joints. Also calcification of the posterior longitudinal ligament of the vertebral joints and the plantar ligaments appears. At the same time there appears everywhere in the extremities calcification of the vessels.

All these changes, especially the ones first mentioned, appear similarly all over the entire skeleton. With the exception of the region of the metaphysis of the long round bones the distinction of cortex and medullary canal is entirely lost. The whole bone is changed into a compact structureless mass. On account of this the bones show an unusual fragility. Similarly, this change appears in the bones of the vertebrae, the feet and the wrists. Every particle of structure is lost and only a dense bone shadow appears with complete preservation of the external form of the bone.

Also the ribs and the sternum show these changes in structure. In the metaphysis of the long round bones the cortex is limited to a narrow edge.

In like manner the borders of the pelvic bones appear calcified in contradistinction to a proportionately less extensive part of the center of the bone where it is completely rarified.

The femur, fibula, tibia and bones of the forearm show a definite bending of the axis, and the humerus shows a club-like thickening.

The left femoral head is in a coxa valga position.

If we turn from the associated reports and compare the findings on the skeleton of this boy with the others as they are set forth by their authors, we see the universal recognition of this definite change in the bones to which all have called special attention. In definitely classic manner do these illustrations agree: for example, the picture of the diaphysis of the femur, the vertebral column and the foot.

The generalization of the changes over the entire skeleton (also shown in our case) is the expression of the entire picture of this malady.

A definite systematic diagnosis of this remarkable bone change was not possible on the basis of the roentgenograms alone. Therefore, welcome indeed was the possibility of completing our roentgen findings by autopsy, since the boy died suddenly with signs of heartweakness, vascular and renal changes in association with his anemia.

The report of the autopsy findings by Professor Hart, was:

"A corpse of male sex of childish habitus, slender bone construction, very poor nutrition and pale skin. Size and development indicate a boy of about eleven years of age.

"The vault of the cranium is long, thick and heavy, the sutures being plainly visible. The saw-cut shows no evidence of spongiosa—the bone is much more uniformly gray-white, fine white patches and short streaks being visible only on close inspection. Only on the tip of the vertex is the brain of a grayish-red color, while on the remaining areas there is a gray-white color with a remarkable veil of fine, dark red blood-vessels resembling an injection preparation.

"On the inner aspect is the dura mater, which is a thin membrane, like tissue paper, everywhere firmly adherent to the bone and not easily separated. Only in the region of the longitudinal sinus can one find heavy folds of the dura. The falx is well developed and completely calcified and there are calcified deposits found in the tentorium. Everywhere the inner table of the vault of the skull shows a definite moulding, and everywhere can be seen the white patches and streaks which arise from the gray-white bone beneath the dura.

"The appearance of the base of the skull corresponds to the above description. Especially is it to be emphasized that all sharp corners are rounded and appear plump and thick, and all foramina show narrowing. The occipital foramen is normally wide and the ligaments at its base are free.

"The processus clinoideus posterior is especially thickened and enlarged, caused by the thickening of the bone. Although the opening of the sella turcica is narrowed, there is normal size of the pituitary body and it appears macroscopically to be of normal structure.

"The features are delicate—bony thickening cannot be felt. The spine is kyphotic in the dorsal region. The vertebral ligaments are thin but tolerably firm. In a transverse section the spinal canal is of normal width and is lined with a soft dura.

"The intervertebral cartilages are thin and firm. The cut surfaces of the bodies as well as the transverse processes show a uniform gray-white quality without any trace of separation of the various parts of the bone. Numberless white patches and stripes are seen on the bodies of the vertebrae.

"The same picture is seen on the cut section of the cross-section of the sternum—only one sees here in the immediate neighborhood of the interarticular cartilages, of which three are present, a dark-red colored zone. In the remainder of the bone it appears on cut and uncut surfaces completely eburnated (ivory-like).

"The long round bones, femur, tibia and humerus show the following: The diaphysis appears as a uniformly firm grayish-white bone substance without any trace of medulla and of any remnants of a definite cortex. The epiphysis shows the same condition except in the immediate border of the joint cartilage where there appears a narrow line of boundary substance, dark red in color. Between the diaphysis and the epiphysis one can see a 2 to 3 cm. zone of dark red color which gradually shades off into the diaphysis, in the neighborhood of which there appears a thin edge of cortex. The epiphysial lines show, in all the long tubular bones, irregularities, which are especially prominent in the femur and humerus.

"These changes group themselves in such a manner that the cartilaginous lines in the center of the thickening and the conical projections toward the marrow are seen with simultaneous strongly marked calcification which appears on the lateral striated portions as uniformly narrow, gray-white borders. In the projecting plugs one can see grayish-white foci of lime salts, not only on the borders, but also within the cartilages. In the femur there lie in the border zone isolated, irregularly-formed islands of cartilage of various sizes and containing calcareous foci. In the humerus, where the border zone of the metaphysis is especially broad, even a bending of the bone is produced.

"All the joints show a flattening of the cartilages but with no abnormal contents, and within, in the capsules and in the ligaments (especially pronounced in the knee-joints) are at times large masses of lime deposits. The ligamentum patellae is markedly calcified.

"The microscopic findings are as remarkable as the macroscopic and are summarized as follows:

"There is a very beautiful picture of new bone formation as much in the periosteum as in the osteoblasts, which exists as a continuous covering but is composed of low flat cells with dark spindle-shaped nuclei.

"The bony edges everywhere are not only narrow and firm and below the normal breadth, but may be even entirely absent.

"The incomplete new bone picture shows especially in the border between the bones and the cartilages of the ribs and long tubular bones, where the metaphysis shows an entirely undeveloped cortex and a very insufficient spongiosa. In the short bones the entire bone picture is one of generally poorly-developed cortex.

"The irregularities of the bone and cartilage zones are dependent for the most part on the deficient activity of the osteoblasts. Osteoblasts were found everywhere, but their number was so small that it constituted real deficiency. Under these conditions, there arises a really complete disappearance of bone construction.

"A relatively increased content of lime salts, for whose etiology we will need to look further, has thereby appeared in the rapid calcification of the osteoids. The degree of thickening of the bone substance is increased because in the narrow medullary spaces chalk masses have been deposited, which here and there have been found in the narrow blood canals and have completely filled the medullary tissue.

"This deposit of lime is partially found in the walls of the arteries, but is most pronounced in the construction of the medullary tissue.

"This occurs exceptionally in the metaphysis, but for the most part is present in the lymphoid tissue, which, in other places more or less separated, is replaced by a fatty tissue or a very loose tissue composed of an extremely soft fibrous reticulum with small fat cells intermingled."

Considering our roentgenograms and the descriptions and accompanying illustrations of the other authors and our examinations of the cut sections of the bones, we would expect the findings of a completely obliterated medullary canal. The bones are of one complete definite gray-white substance without a visible sign macroscopically of a medulla. Through the deposit of free masses of chalk, in the interior of the marrow, the sp. gr. of the bones is thereby considerably increased. The bony foci of the epiphysis are calcified at the same time, a finding that Sick had already noted from the roentgen research of his cases.

The bony changes involve the entire skeleton. The change in composition of the skull and the base of the skull, which it was not possible previously to prove radiographically, is now known to have taken place just as it had in other bones.

Especially do the posterior clinoid process and the sella turcica illustrate this—a finding that has impressed itself upon the other authors when the knobby and clubbed areas of thickening have produced a reduction of size of the hypophysis.

Worthy of remark is the noticeable narrowing of all of the foramina at the base of the skull. These changes in the foramina give a reason for the fact that there is so commonly demonstrated an optic atrophy, and give as a plausible reason that it is the result of such a narrowed foramen affecting the optic nerve, just as, for example, in tower skull.

Also the nystagmus that was described by Laurell and Wallgren in their case could be explained in the same way by a narrowing of the outlet for the eighth nerve as it leaves the skull.

In addition to the earlier investigation in which the thickening process already had invaded the epiphysis and the neighboring parts of the diaphysis, do we find here in our case the process first in its onset.

This circumstance makes it possible for us to construct a picture of the condition, which, in our judgment, lays special emphasis on the epiphysial lines of the bone changes.

The characteristic appearances are brought to our attention through the *x*-ray. The microscopic examination demonstrates that there are conditions here which resemble rickets.

Everywhere the microscopical picture shows, aside from the marked increase of lime content of the bones, entirely with the suggestion of an extremely inactive bone process, a rapid complete destruction of the normal bone picture.

To give a safe explanation of the nature of this malady is not possible from the purely anatomical findings. The well-established changes do not allow a definite classification under the known diseases of the skeleton. Our attention was naturally turned in the first place to the known results of osteitis fibrosa in a general osteosclerosis.

Not considering the roentgen findings which lack the usual marked deformity of the bones, all the less does the microscopic investigation speak for one of the known diseases. Above all does the nature of the marrow speak for this, which alone allows the conclusion that a disease emanating from the marrow cannot be responsible for such a bone change.

It also shows in this connection that the opinion advocated by Reiche, that we have to do here with a resultant osteosclerosis with a myelogenous leukemia or pseudoleukemia, appears to have no basis.

There exists here, as already mentioned, a resemblance to the picture of rickets as it shows in the appearance of the growing zones of the bones. Only the characteristic sign for this is missing, viz., the abnormally broad edge of the osteoids.

There is also missing anatomically the possibility of demonstration of the malady as a juvenile osteomalacia, because of the fact that, along with the changes in the growing zones of the bones, the composition of the osteoblasts and, as well, the remarkable thinning of the cortex of the metaphysis, testify against such a conception. Microscopically there are the following findings:

Very small many-sided open spaces in the edge of the growing bone in which the signs of new periosteal bone are very little in evidence. The bone makes, in many ways, an immature appearance, because of the breadth of the small bone cells. The cambium layer of the periosteum is very definitely noticeable; it shows, however, only flat spindle cells and nuclei without zones of growth. On the inner side lies the thin cortex with only a narrow or even no border of osteoids

Also, even here, judging from the new bone picture, no anatomical ground for the diagnosis of an osteomalacia can be seen.

Nevertheless, we are inclined to assume for the case a primary existence of a rachitic-osteomalacic process as the bone malady.

We are led to this conclusion because of the definite characteristic irregularities of the growing zones of the joints and a group of exclusive bone changes which we have seen in our case, as well as the descriptions and plates of the other authors. A sickle-shaped thickened posterior clinoid process is common to all: the drum-stick thickening of the heads of the fibulas described by Albers-Schönberg, the pestle and club-shaped thickenings of the joints of the upper and lower thigh and the proximal joint heads of the humerus as described by Sick. The knobby appearance of the lower ends of the femurs, as well as the upper end of the humerus was found in our case, concerning which we go much further in investigation than the Laurell-Wallgren research, and agree with them in their conception of the etiology and their judgment concerning the changes of form as seen in the coxa valga position—in Laurell-Wallgren's case there was a bilateral coxa vara—likewise in regard to the characteristic bendings of the diaphysis of the humerus, femur, tibia, fibula and lower arm bones that can be shown.

All these changes are so characteristic that they, even in the absence of the thickening process of the bone and the high chalk content, do not, for a moment, leave us in doubt as to their rachitic-osteomalacic origin.

Very typical is also the antecedent history of the Laurell-Wallgren case: First the boy was able to walk without help only at two and a half years, the first teeth erupted at the end of one year and the eruption of the later teeth was delayed and irregular. Finally, in his third year, the diagnosis of "rickets" (English disease) was made by his physician.

With the frequency of hydrocephalus in rachitic disease, the frequent occurrence in association with the disease of the skeleton that we are discussing speaks for our opinion as stated above.

Also the family history speaks for this as fully as do the disturbances of growth in such a process as was found in every case of our research.

While it is not possible to exhibit the process of thickening by section of any resected bone by which we could show the microscopic changes of rachitic-osteomalacia, there is the probability that the original underlying malady came to a standstill, or that there had been a rachitic-osteomalacic process overlapped by some outside process in which there had already been a deficient lime-content throughout the entire organism with an excessive sugar retention and accumulation.

To this exhibit is added, in addition to the lime richness of the bones, the finding of the unusual calcification to the greatest degree of the whole organism, which in our case accompanied the changes in the bones.

We have spoken above of the calcification of the patellar ligament, the plantar and Achilles tendons as shown by the *x*-ray; of the periarticular calcification of the hip and knee-joints and the posterior longitudinal ligament of the spine; and of the arteriosclerotic changes definitely palpable and sometimes seen in the *x*-ray plates.

Far beyond our expectation does the autopsy confirm this opinion, and discloses everywhere increased calcification in the arteries of all the internal organs: the lungs, which show everywhere the appearance of pumice-stone; the myocardium of the left heart, the mesenteric vessels with their branches; the renal vessels, etc. In short, in addition to the known changes could be seen the peripheral vessels and the arteries of the internal organs changed into stiff chalk tubes, with the exception of the thoracic aorta, both carotids and the vessels of the brain.

Especially marked calcification was seen in the posterior parts of the tracheal rings and lime deposits were seen in the mucous membrane of the stomach, and lime infarcts in the kidneys.

With all these changes present in complete unison, we find in the blood double the normal value of the contained lime salts, despite the fact that the examination of the urine showed a normal output.

So there appears in the foreground of the malady, in our case, an unusual lime content of the collective organism, while there appears in the comparison cases much the same condition, although exceptionally the lime is found only in the bone tissue.

Keeping in mind the reports of the other authors concerning the excessive callus picture and the rapid union of the fractures in every case under observation, it appears that because of the excessive content of the lime salts in the blood, favorable and rapid healing process could occur. The time required for repair of the bones has in every case been reduced to the minimum, not only in our case, but in the others reported.

The amount of lime in the bones makes it understandable, that from the moment of the entrance of the usual rachitic-osteomalacic process nothing more need be said, because to this malady definitely belongs the reduced capability of the organism to utilize the lime salts for the destruction and reconstruction of the bones.

Whether the cause of the deficient storehouse of lime is due to a reduced lime retention or whether it has arisen through a reverse process and the underlying process has been revived, cannot be determined from my own researches alone.

We have proved in our case the great increase of lime content, yet we were not able to show conclusively the signs of poverty of the bones in lime salts, as we had been able already to show concerning the conditions of the epiphysial lines: for example, the abnormally broad border of the osteoids.

It becomes, on the contrary, perfectly understandable that in the presence of such an increased supply of lime, the rarely seen osteoids must everywhere be subject to a rapid calcification.

So it seems that the real thickening process involving the bones in our researches is to be explained by the destruction of the normal bone by slow and extended new bone as a result of the increased lime value in the blood. Only this could make possible in the course of time the slow eburnation of the bones to such a degree.

Also, the marked deposits of chalk that have been shown to form in the medullary canal can be undoubtedly explained by the abnormal lime content of the blood. They indicate, especially in the deficient storing up of lime in the other parts of the body, as shown in the other cases, how greatly the bony system can be changed because of physiological disturbance of lime ingredients in other organs.

It can be understood also that the well-known lines of calcification found in a rachitic process, lines that were described by Albers-Schönberg, Sick, and, in more detail, by Laurell and Wallgren, have been seen to be as characteristic for the bone changes in our case, and hence would, under such circumstances, bear more weight.

It is very apparent that with such an insignificant amount of lime as enters into this question, a duration of the increased lime content of the blood for only a year would account for the remarkable changes.

This circumstance also explains why, in our case, the young zones of the bones had not acquired as yet such richness of lime as the older zones—the diaphysis and the older portions of the pelvic bones, for example.

The duration of the process alone can be explained in the manner indicated especially by Laurell and Wallgren, in whose case the bones had not reached such full lime density as in the case presented by Albers-Schönberg.

One could try in this manner to explain the picture of this malady of marble bones as an exaggerated healing process of a rachitic-osteomalacic bone change. Such a conception could be justified when, with the appearance of the increased retention content of all the organism it would have to do with a return to normal composition in the process of destruction and reconstruction of bone. To complete a judgment of such a question the microscopical findings are especially valuable in our case. They show definitely that such a reversion process has not taken place.

When the primary softening of the bones productive of the deformities has been brought to a standstill because of the unusually rich lime supply, then this disturbance disappears also, which can be considered as the outburst of the oldest disease process; that is, the extremely inert action of the osteoblasts whose deficient performance, as above described, is especially seen in the metaphysis of the round bones and the ribs and in the newer part of the pelvis, as seen in our case.

If we follow the conception of the other authors, who believe the nature of the osteomalacic process to be of such a quantitative and qualitative disturbance of the activities of the osteoblasts with a normal precedent activity of the osteoclasts, it would appear that in this action the inactivity of the osteoblasts serves very well as the last existing sign of the basal lesion, just as the rich lime salts content of the blood had equalized the qualitative disturbance of the body.

In the continuance of the inactive new bone picture we might, in every case, see a hint in the progressively completed structural changes seen in the bones—not as a healing of the original rachitic-osteomalacic process, which idea is not accepted by us. Our opinion reaches further—that the primitive bone malady is overlaid through the appearance of a severe growth disturbance of the lime elements, which, in its path, has obliterated many definite signs of the basal lesion, and in other places has allowed them to remain.

So there are in places through the roentgenograms definitely discernible softened areas and curvatures due to the deficiency of lime salts, or because of this impoverishment of the lime content an actual lifeless stiffness of the bones has occurred. This underlying and basal modification of the structure of the bones gives us the explanation of the commonly observed fractures that occur in the presence of such changes in the bones.

Because of the arrest of the normal architecture of the bone and the gradual storing up of a large amount of calcium salts in the inner portion of the weak and deficient spongiosa surrounding the medullary canal, the bone has lost its normal strength; it becomes, paradoxical as it sounds, fragile, because in places the living tissue has been changed into a mass of lifeless inorganic substance. This process speaks also for our earlier conception.

Strange it is that it had not come, or rather not *yet* come to the stage of fractures in our case. Whether especially favorable external circumstances impeded the process, or whether the circumstances can be considered at all as responsible, the question as to whether we have to do in our patient with an undeveloped process must remain unsettled.

In the line of the investigation which endeavors to explain this skeletal disease, our case up to the present is the only one in which calcification of the soft parts in the neighborhood of the skeletal changes have been definitely demonstrated because of the death of the boy.

We will venture that the distinction is entirely the outcome of a high grade increase in the blood composition.

Perhaps, however, the age of life and the beginning of the affliction play a rôle. In our case, the malady had first set in in the so-called "second-evolution period" of the bone growth; while we must consider the origin of the other cases as in the "first evolution period," for which possibly a relatively higher absorptive ability of the bones in lime salts is accountable, as seen in the later periods of growth.

Laurell and Wallgren have sought in their case to determine the nature of the disturbance of the lime ingredients from the analysis of the mineral elements. This they have not been able to prove from their supposed increase of lime composition. Indeed the balance of the lime elements remains always positive, although the retained lime values were remarkably low.

The acceptance of a forced feeding of lime into the tissues cannot be upheld from their case.

From our observation, such an explanation cannot be considered. The external environment under which the patient lived makes the acceptance of the idea more improbable, especially as the illness appeared during the war period, under which the conditions of nutrition for our city youth were known to cause early skeletal changes produced by a deficient lime content in the food.

It is much more reasonable to assume that the quantities of lime received by the body are too high for the demands.

We have been able to show, as the especially prominent feature, a remarkable inactivity of the new bone process in our case, under whose influence proportionally extended sections of the skeletal system have shown the stamp of poor development.

We have no doubt that this inert new bone picture is responsible for the accomplishment of the increased lime content of the blood, and that it acts as the starting point of the disturbance of the lime ingredients.

Recently Pick[7] has discussed the question of the meaning of the macroscopic bone changes which are not always explainable and which result in the storing up of lime in the organs just as we have demonstrated in the bone changes in our case, and as they appear in classic bone metastases. Pick supported everything on the conception deduced from the study of osteitis fibrosa, especially of the bone structure.

But as to how this brings about through the progressive exhaustion of the bone substance an enrichment of the blood with lime salts, we have this to suggest; that there, in an analogous manner, a progressively increased lime content of the blood must be produced, because, following the low grade of activity of the osteoblasts, too small a number of osteoids will appear, so that the nourishment which carries the lime will be incompletely utilized; or, in other words, there appears here a surplus because the levy is greater than the actual need for the new bone construction. Here our observation has a broader significance, because it directs attention to a close observation concerning the disturbance of the lime salts necessary to growth. It is difficult to explain how a progressive definite enrichening of the blood with lime salts can occur without an extensive disturbance of the lime elements, e.g., a disturbance of the elimination of lime. Such an enrichment of the supply of the lime salts can only be understood when, as in our case, we find double the normal lime value of the blood.

We now consider the most difficult question of the whole subject of lime ingredients in the blood and urine. For some time Virchow had held the kidneys and their eventual inflammatory changes as the explanation of the problem, because in the predominating majority of remote calcification changes extending throughout the body, more or less severe kidney changes were found.

According to Virchow's[8] conception the normal excretion of lime through the inflamed kidneys is hindered, and so an overloading of the blood with lime salts occurs.

This idea of the kidneys associated with the inflammatory process in them has recently been disputed, because researches, while isolated, yet apparently substantiated, have given evidence that the same severe disturbance of lime ingredients has also been possible with healthy kidneys.

It is especially important to remember that the chief points of excretion for the lime are the salivary glands, the gallbladder, the bronchial mucous membrane, and the mucous membrane of the colon; and that, compared to them, the elimination of lime through the kidneys is small. According to this, the cases of nephritis studied that have shown so-called lime metastases, or even those claimed by Virchow, could be included in this conception. Their influence is felt only in a reduction of the proportional solubility of the lime salts in the circulating blood (M. B. Schmidt[9]).

So worthy and valuable an argument as the last is itself safe as an explanation for the deposits of lime salts, but does not explain the real increase in lime content in the blood.

So there prevails even now a real uncertainty in regard to the unusually difficult question, which only ultimately will be removed when we have established the lime content of the blood in all such cases, perhaps after research into the catastases,[10] ultimately searching for places in the organisms which act as storage points for lime, places as yet undetermined but normal in their action.

The clinical investigation alone of patients who suffer from the severe destructive processes of the skeleton, e.g., osteomyelitis, will show how significant the removal of lime salts by the kidneys is, in spite of the other means of elimination.

If we follow the urinary secretion of the same type of patients, especially in cases of marked sequestrum production, we may be surprised to find now and then definite increase in the excretion of calcium salts by the urine; the usual very marked chalky sediment composed of lime salts that is found in urine after standing.

Virchow had already observed this chalky sediment in the urine in connection with destructive processes of the bones. v. Recklinghausen[11] placed it under the clinical findings of metaplastic malacia (osteogenesis imperfecta), a markedly characteristic observation in the increasing destruction of bone.

In our own cases of osteomyelitis this symptom has been common in this connection, and the lime value has not been inconsiderable, which was eliminated in association, for the most part, with an increased amount of strikingly clear urine, and so acted as a regulator to prevent an excessive enrichment of the blood with lime salts.

Certainly these amounts held in retention are small as compared to the amounts eliminated. At the same time, if the disturbance were of the secretory apparatus of the kidney, as we have in a case of nephritis, it would be more noticeable in the elimination of the calcium through the urine. There is no complete suppression of the calcium salts elimination through the kidneys.

Because of the proportionally small lime value always present, which, under such circumstances, produces a slightly increased retention in the body, there will always be an increased calcium richness throughout the bones, and, if there be a kidney disturbance, there will be a remarkable increase of the lime content of the blood.

It is impressive in this connection that in the great amount of osteomyelitic material seen in our great clinic, only a single time has there appeared a case of definite storing up of lime in the organism, perhaps in the sense of a lime metastasis (autopsy could not be obtained). The conditions were determined by roentgen findings, and in the course of the disease a severe nephritis appeared.

As careful and definite determination of the lime content of the blood convinced us, there comes, even with clinically intact kidneys, in some of the various surgical diseases, a considerable elevation of lime content. The diseases included were phlegmon and circumscribed abscesses of long standing.

The hypercalcification disappears with the disappearance of the infection, returning to the normal in the course of the disease if the case be not of too long standing, with no signs of the calcification remaining.

For us there is valuable evidence in the case, in that under such circumstances, chiefly with clinically intact kidneys, a reduction of the lime elimination and an increase in the lime content of the blood occur.

In connection with the increased blood calcium we must consider the overactive process in the organism, which leads to such an accumulation, as resting upon a biological basis because of the limitation of the lime output.

It is important, in this connection, to be able to make a definite organ responsible. One would very advisedly mention a definite resemblance with such a process as we find in hyperglycemia. It would seem more reasonable since we have learned to think of the malady under observation as due to a property of the secreting epithelium of the kidney and to think of such a tendency in the increased calcium output through the kidneys, and analagously as with sugar a sort of inflamed kidney due to the presence of lime.

The periodic character of most cases of appearance of excessive amounts of calcium salts in the urine appears to point to the existence of such states as have been referred to by others, e.g., Umber.

It was unusual for us to find in any case a content of lime equal to that found in the urine of a boy with periodically increased calcium output, who, in the interval, had a normal blood lime content and a lime content of the urine far below the normal. The boy developed multiple subcutaneous collections of lime, which, in their growth, in every case, showed definite, visible and periodic fluctuations in size.

We believe this can be explained as the unquestioned result of the disturbance of lime elimination through the kidneys, perhaps dependent upon the same kind of a thickening of the kidneys as seen in the periodic changed elimination of the calcium by the kidneys with an incomplete adjustment of the balance.

If one keeps in mind the dependence of the lime ingredients on the influence of the thyroid and the parathyroids, the natural thought is that the final organ of the action appears in every case to be the kidneys.

The presentation by Laurell and Wallgren gave prominence, at least, to the increased blood-lime content to which we have definitely called attention in the earlier part of this article; likewise a remarkable thickening of the kidneys in the case of the observation of a rather considerable increase in the amount of blood-sugar. Perhaps this observation points directly to a definite parallelism between blood-lime increase and blood-sugar increase, as we find an increase of lime elements is associated with diabetes.

So there appears to us a group of phenomena in the conception of an inhibition or disturbance of the lime elements, which we have collected, pointing to the kidney for its origin (clinical changes being even absent). Because of our knowledge obtained by the study of the formation of the sugar elements, we were able to show, to all appearances, the cause of such inhibition or disturbance to lie in the contents of the secreting cells of the kidney epithelium, sufficient to impress us much more than all the unknown causes.

In this conception we were supported by the idea suggested by M. B. Schmidt in his description of the malady, *kalkgicht* (gouty lime deposits).

Under these circumstances, the state of the kidneys in our case emphasized our other observations all the more, as we had established clinically a chronic nephritis and shown primarily, in addition to that, that this (perhaps as the result of the long-continued scarlet fever) was the cause of the overloading of the blood with lime, as in the older idea of Virchow.

As now, however, the investigation of the kidneys progressed, the question arose whether it was a hyalin degeneration of the glomerular loops following the calcification and an obliterating endarteritis, or whether it was a process which began at first as a result of overloading the blood with lime, and which was indicated by a general blood-vessel calcification.

Again, as a primary causal factor for the increase of the lime content of the blood, the question arose: could the kidneys become more responsible under these circumstances of actual change?

So we were compelled, as the final explanation for the result of the increased lime content in the blood seen in the description of the malady here, to suggest the disturbance of the power of the secreting kidney epithelium as a cause of the previously mentioned inhibition of a reactivated process, according to the idea of Arndt-Schultz that there is a possible primary underlying stimulant to the lime elimination.

Consequently, when we grant that in our case no primary causative reason of the nephritis could be found, there yet remains another doubt in our mind, whether it has influenced the whole picture during the time of its presence through a wide destruction of the ability to eliminate lime salts and through the destruction of the condition of solubility of the lime salts in the blood serum.

It might be mentioned at this point, that the statement of the parents of our boy that he had shown in the course of the disease a periodic high calcium elimination by the urine, might be a proof that this symptom, contrary to many other views that have appeared, had yet rather an important diagnostic significance.

The dependence of the lime ingredients on the various endocrine glands has been demonstrated experimentally as well as shown clinically in the isolated cases; namely, the thyroid, parathyroids, and possibly, also, the thymus gland. It seemed likely that such an associated dependence could surely be proven in our case, more especially as Laurell and Wallgren believed they had been able to prove that an aplasia of the thyroid and a hypoplasia of the hypophysis had belonged to the completed picture of the disease.

We found all the endocrine glands unchanged in size and structure, the thyroid and parathyroids, of which there were three definitely demonstrated, showing no change that could be made to indicate either hypo- or hyper-function of the gland.

A very marked calcification showed everywhere in the various arteries of the parathyroids. Whether we are justified because of this change to consider the results due to the changes of the secretory ability, we must be allowed to consider.

At no time was it considered that this might be a cause for the disturbance of the lime elements.

That also the hypophysis seemed to be of normal size, although it was contained within a narrowed boundary, we have shown in the information obtained from the autopsy. That it also showed microscopically a normal appearance, is in accord with the idea of Laurell and Wallgren, and apparently with Sick and with Lorey.

Personally, I am impressed with the fact that the youngest case reported, that by Lorey, was but three weeks old, and the oldest case when discovered (my own) a woman, forty-three years, and both showed almost identically the same findings. Now the question arises: is the patient born with the highly calcified lime condition? In other words, is the process antenatal in origin, or can it develop in late life? All but 2 of the 8 cases have been in children, and in my own case there was no marked clubbing of the bones, as would be expected if the process were the rachitic type developing in childhood. One may answer this, in a way, by saying that rickets and osteomalacia are essentially the same pathological process in the result of rarification of the bone, but one occurring in growing bones leads to more deformities, the overlying process leading to similar appearances of the bones when the high degree of calcification occurs. One can hardly imagine such bones as appear in my patient as having grown from infancy in such a disorganized state of the bone-forming cells. The whole theory of bone growth is upset by it.

The marked callous formation in the cases of the children, and the absence of such in the case presented may be accounted for by the age of the patients.

Another disturbing question is: why do not more cases occur, if the kidney function be the main cause of the lime retention? Personally, I do not feel that the etiology of the disease has been determined; and only as cases multiply, and autopsy records show the bone findings, can any progress be made.

BIBLIOGRAPHY

1. Schulze, Fritz. Das Wesen des Krankenheitsbildes der "Marmorknochen (Albers-Schönberg)." *Arch. f. klin. Chir.*, cxviii, Festschrift für August Bier, Nov., 1921.
2. Albers-Schönberg. Roentgenbilder einer seltenen Knochenerkrankung. *Arzt*, ix, 2, 1904. Eine bisher nicht bescriebene Allgemeinerkrankung des Skeletts im Roentgenbilde. *Fortschr. a.d. Geb. d. Roentgenstrahlen*, 11.
3. Sick. Uber drei Fälle einer seltenen Skeletterkrankung (Marmorknochen, Albers-Schönberg). Festschift z. Feier des 25 jährigen Bestehens des Eppendorfer Krankenhauses, 1914.
4. Lorey. Uber sine sehr seltene Allgemeinerkrankung des Skeletts (Marmorskelett). *Verband. d. deutscb. Röntg.-Gesellscb.*, 11.
5. Reiche. Osteosklerose und Anemia. *Müncben. med. Wcbnscbr.*, 1915, No. 28.
6. Laurell and Wallgren. Untersuchungen über einen Fall einer eigenartigen Skelett erkrankung (Osteosclerosis fragilis generalisata). *Upsala Läkaref. Förb.*, xxv, h. 5–6.
7. Pick. Die indikatorische Bedeutung der Kalkmetastase für den Knochenabbau. *Berl. klin. Wcbnscbr.*, 1917, No. 33.
8. *Virchow's Arch.*, 8 und 9, Die Kalkmetastase.
9. Schmidt, M. B. Kalkmetastase und Kalkgicht. *Deutscbe med. Wcbnscbr.*, 1913, No. 2.
10. Katase. *Ziegler's Beitr.*, 57, 1914.
11. v. Recklinghausen. Rachitis und Osteomalacie. Jena, 1910.
12. Roth, M., and Volkmann, J. Osteitis Fibrosa. *Mitt. a.d. Grenzgeb. d. Med. u. Chir.*, 1920, xxxii, No. 3. Abst., *J. Am. M. Assn.*, Feb., 1921, p. 558.
13. Lovett and Wolback. Roentgen appearance of some obscure cases of bone lesions. *Surg., Gynec. & Obst.*, Aug., 1920, xxxi, 111.
14. Ruggeri, E. Idiopathic Osteopsathyrosis. *Petiatria*, Oct. 15, 1920, xxviii, 953. Abst., *J. Am. M. Assn.*, Jan. 8, 1921, lxxvi, 145.
15. Bland-Sutton, J. Secondary deposits in bone mistaken for primary tumors. *Proc. Roy. Soc. Med.*, Dec., 1919, Surg. Sec., 13, p. 1.
16. Phemister, D. B. Studies in reduction of bone density. Am. J. Roentgenol., July, 1921, viii, 355.
17. Clark, J. J. Diagnosis of bone diseases by *x*-ray. *J. Med. Assn. Georgia*, May, 1921, x, 442.
18. Wright, H. P. Fragility. *Canad. M. Assn. J.*, June, 1921, xi, 427,
19. Blegvad, O., and Haxthausen, H. Blue Sclerotics with fragile bones. *Hosp.-Tid.*, Sept. 28, 1921, lxiv, 609. Abst., *J. Am. M. Assn.*, Dec. 10, 1921, lxxvii, 1934. Abst., *Brit. M. J.*, Dec. 24, 1921, ii, 1071.
20. Burns, C. W. Fragilitas Ossium. *Canad. M. Assn.*, Aug., 1921, xi, 522.
21. VanderVeer, E. A. and Dickinson, A. M. *Am. J. Surg.*, Nov., 1921, lxxiv, 629.
22. Borzini, A. Surgical bone and joint diseases. *Tumori*, Aug., 1920, vii, 215. Abst., *J. Am. M. Assn.*, April 30, 1921, lxxvi, 1285.
23. Ström, S. Roentgen diagnosis of osteitis fibrosa and other affections of the bones with similar roentgen appearances. *Acta. Chir. Scandinav.*, Dec., 1920, liii, 175 (in English). Abst., *J. Am. M. Assn.*, April 2, 1921, lxxvi, 974.
24. Kienbock, R. Roentgen diagnosis of tumors and affections of the bones and joints. *Wien. klin. Wcbnscbr.*, Sept. 29, 1921, xxxiv, 472, and 2 following numbers.

25. Comby, J. Fragility, present status of. *Arch. de méd. d. enf.*, Jan., 1919, xxii, 31.
26. Turner, W. I. Hereditary fragility of bones. *Am. J. Surg.*, Aug., 1918, lxviii, 231.
27. Stewart, H. M. Roentgen diagnosis of bone lesions. Am. J. Roentgenol., Feb., 1918, v, 77.
28. Holmes, G. W. Osteomalacia. Am. J. Roentgenol., Nov., 1918, p. 507.
29. Giles, R. G. Rickets, a study of, with review of recent literature. Am. J. Roentgenol., June, 1922, p. 360. (This article has an excellent bibliography on subject of rickets.)

ERRORS IN INTERPRETATIONS OF LESIONS OF THE SINUSES*

BY F. M. LAW, M.D.

NEW YORK CITY

I WOULD like to mention two or three points which make for errors in the interpretation of sinus plates.

That the interpretation of a plate consists in basing diagnosis on the appearance of the degree of opacity of the sinuses is well and good, but there are conditions which are indicated by other appearances than opacity of the sinuses. These conditions are in that large class of cases which are indefinite, with indefinite symptoms: just the type of case the surgeon is particularly interested in, and which he hopes will derive the most benefit from a roentgen examination. Now the most frequent error, of course, is to report a case as a positive sinus and have the surgeon declare it absolutely wrong. This is a very common occurrence in my work, and, I presume, in that of others. I make a report of a negative sinus, particularly in the case of the antrum; the next day the surgeon calls up and tells me what he thinks of me. He opened the antrum and found it full of pus. The plates showed perfectly transparent shadows where the antrum should be and yet he did get a quantity of pus out of the sinus. What is the trouble? Ordinarily we think the *x*-ray should not lie. However, there is a very definite reason, and when we consider that reason, it helps out materially in a complete diagnosis.

A patient goes into a surgeon's office with symptoms of sinus involvement. The surgeon naturally puts adrenalin or cocain in the nose, which shrinks up the membrane; he possibly finds pus coming down underneath the turbinate bone. He is fairly confident that there is a sinus involvement; he sends it to your *x*-ray laboratory; the plate shows a perfectly transparent sinus and you make such a report. Patient goes back; there is still pus; surgeon opens the antrum and finds pus. The reason for this is that in the interval between the examination of that patient and his presence in your office he blows his nose, completely draining both the ethmoids and the antra. When you get the case you have a perfectly clear sinus; there is no pus there. In the meantime pus accumulates, and when the surgeon sees the patient again he finds it, and your report is wrong; but your diagnosis from a differential point of view is made more valuable. Surgeons have asked me if I could tell the difference between granulations and pus. I cannot, on the plate, but this case shows that difference. The fact that there was pus there and he found pus, and your plate showed a clear antrum or a clear ethmoid shows that there is nothing present but pus—no granulations or polyp.

Now take the other case: A patient comes in and you make examination and find a positive antrum. The surgeon operates, punctures the antrum, possibly, and finds nothing. Your plate again is wrong. You make a second examination and still find an opaque antrum. He finds nothing on puncturing, but if he should do a radical on that antrum he would find it full of granulations. So there is your differential diagnosis. Make two examinations if necessary. If you get an opaque antrum and it is punctured and found clear, and you make another examination and still find an opaque antrum, you can rest absolutely assured that the antrum is full of polypoid tissue.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922. Discussion on this paper and others in the sa me symposium will appear in a later number of the Journal.

So although you have made an error in your report, a consultation with the surgeon will clear up the case and make for a differential diagnosis, which helps both the surgeon and the patient. You are right in your report, but your report did not go far enough.

There is another case: You may report a positive opaque antrum. The operation, much to your surprise, may prove that there is no antrum there. We have often considered, of course, the absence of a frontal sinus, but how many consider that there possibly may be absence of an antrum? It occurs, and fairly frequently, and your plate in that case will show opacity where the antrum should be, but with properly made lateral plates the outline of that antrum will not show. If it is very faint, it may be the antrum on the opposite side. Considering the possibility of such a case, it is wise to make a second examination, possibly in the oblique position, so as to separate the two sides of the face, and differentiate between the right and the left antrum.

There is still another condition which will show a positive antrum and, on operation, no pus, but no relief of symptoms. If you examine that case very carefully in the lateral projection, you may find a double antrum. This is another anatomical peculiarity which does occur. Your plate will show an opaque antrum and the operation will give no results because the puncture made in the ordinary place and position for a puncture has gotten into the anterior half, which is clear, leaving pus in the posterior half, which is purulent. Notice your lateral plates and you will find on the floor of the antrum a projection upwards, showing that there is a tendency frequently for a septum to form that does complete itself, and you have a complete anterior and posterior half to an antrum. This is not common, but the possibility is there; and in these cases where your report is wrong, apparently, and you are trying to find the reason for it, consider that possibility.

The same condition can occur in the frontal sinus. There can be a double sinus with an anterior and posterior half, positive or negative as the case may be.

Now we have a type of case in which there is evidence of sinus involvement, particularly the frontal. The plate shows a perfectly clear sinus. Still that does not help the surgeon. He has an obstreperous case of headache.

I feel that we have always looked for gross lesions, for a definite shadow on the plate. I think we can find a great deal more information in these indefinite cases from considering the outline of the bony structures—the quality of the bone entering into the formation of the septa. Every once in a while you find evidence of a chronic inflammatory change, and that chronic change is what causes those symptoms which are difficult for the surgeon to account for. For instance, in the lateral plate the position and size of the ethmoid capsule—I wonder how many have examined the ethmoid capsule in the lateral plate. It is really important. If it is situated far forward and consists of large cells, there is the chance that an inflammatory condition of the ethmoids may close the infundibulum entering into the frontal more readily than where the ethmoid capsule is small and situated well back.

Supplement your negative report of sinus trouble in these indefinite cases; it may help the surgeon in his decision as to whether it would be wise to remove the anterior tip, perhaps, of a turbinate bone. There is a possibility that the anatomical structure there is such as to favor development of this intermittent type of sinusitis; those cases which have sinus symptoms one or two days and then subside; the kind that are really difficult to do anything with.

Any help, even the slightest, which you can give the surgeon may be the turning point, and the anatomical configuration in the anterosuperior ethmoid region may be that turning point.

One other type may be mentioned: that chronic type which is shown very definitely by wasting of the ethmoid septa, particularly in the posterior ethmoid region; a chronic, hypertrophic type of sinusitis which is indicated by some absorption of the ethmoid septa; cases in which the history does not show them to be chronic. The disadvantage is that the patient has become accustomed to it and has innocently led the surgeon to believe it is not of long standing but something of only a few months' duration. Notice the condition of the ethmoidal septa and base your diagnosis on that appearance rather than on the transparency or opacity of the cavities themselves. If the septa are thinned out, absorbed or thickened from an osteitis, it must be a chronic condition and it is for you in consultation with the surgeon to determine the type of chronic condition. There are reasons for the difference between your report of the case and the subsequent operative findings. I feel that if we pay more attention to the bony configuration, the character of the bony walls, the septa, and the walls of the sinuses, learning to know what is normal and what is pathological so far as that bony structure is concerned, we will give a great deal more help to the surgeon than by simply saying there is or is not pus present in those cavities.

STANDARDIZATION OF X-RAY EXPOSURE IDENTIFICATION*

BY EDW. S. BLAINE, M.D.

Associate Professor of Roentgenology, Northwestern University Medical College; Consulting Roentgenologist, Cook County Hospital; Director *X*-Ray Department, National Pathological Laboratory

CHICAGO, ILLINOIS

THE subject of a standard identification of the *x*-ray exposure, either film or plate, does not appear to have had the attention it deserves in view of its importance in roentgenological work. This observation is the result of a more or less considerable experience in consultation *x*-ray work, exposures on film and plate from various parts of the country being sent for opinion. These exposures reveal a lamentable lack of proper identification which calls for serious attention. Many roentgenologists, however, have an adequate marking system, and obviously much of what follows will not appeal to them.

It is found too common a practice to make exposures without any indelible marking which will give unalterable evidence of several important and vital factors which enter into the identification of any given exposure with any given individual who presents himself for *x*-ray study. The careful roentgenologist observes a technique that betokens ample care, so that mistakes do not often occur. The use of rubber stamps, gummed labels or other similar procedures cannot be regarded as sufficient, because they are applied after the film has been handled by one or more assistants in the laboratory. In some instances, certain exposures have been inadvertently assigned to the wrong patient. In a few cases, substitution of exposures has been done with intent for one reason or another. This has been established in certain instances; one is the case of a short stout woman of forty-five whose gastrointestinal tract was examined by someone claiming to be a roentgenologist, who gave her her plates with a diagnosis of a gastric ulcer. She took these to her physician, who was not convinced that the findings were correct, inasmuch as the clinical evidence failed to support them. He therefore asked for an opinion by another roentgenologist on the evidence submitted. At first glance at the plates it is apparent that they are not those of the patient who presented them. She is a stout woman of 140 lbs. Two 11 × 14 plates show a slender narrow waist well within the edges of the plates which were placed lengthwise to the patient. The shadows are those of a slight, slender woman, of approximately 100 lbs., the bone shadows indicating twenty to thirty years of age. The lady took much offense when I informed her that these plates belonged to another, and she countered by showing me the position of the gastric ulcer which the roentgenologist (?) had indicated to her with pen and ink arrow.

This is but one of several more or less similar instances which need not be detailed, in support of this presentation, the purpose of which is to encourage the adoption of a standard identification which will prevent such intentional as well as unintentional assigning of plates to patients to whom they do not belong.

---

* Read at the Midwinter Meeting of the American Roentgen Ray Society, Atlantic City, N. J., Jan. 26–28, 1922.

The accidents of unintentional substitution cannot be condoned, because of the simple manner in which such happenings can be easily avoided. Some roentgen workers use a simple serial marker of opaque figures, which is far better than nothing at all. But here, too, the chances of error are still too high.

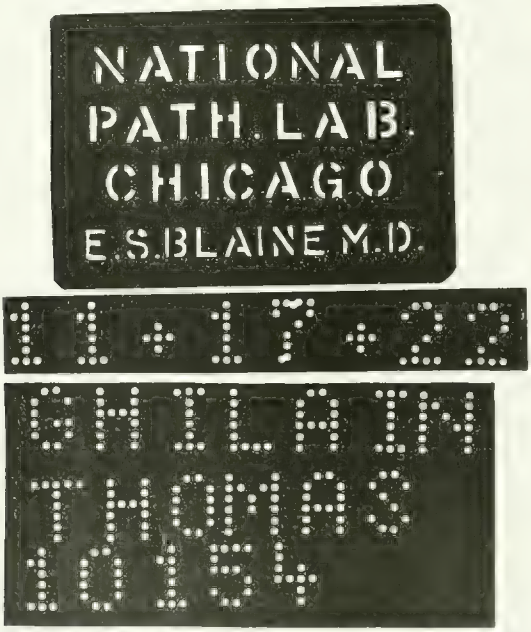


Fig. 1. The significance of the several lines is detailed in the text; the sequence is optional but each line is of utmost importance.

It is true that when very few, say, one or two cases a day, are examined, the chances of mistakes in identification of films are small, but if two cases of the same anatomical part are exposed on the same day, the patients being approximately the same size, age, sex, etc., the chances for error are greatly increased. The writer knows of an instance in which this occurred: a renal stone was diagnosed and operated for in one patient, when it really was in the second patient; due to the exposures being mixed up.

Another factor in exposure identification is that of determining the right and left side of the anatomical part exposed. This cannot always be established when no identification is used. Obviously an opaque "right" or "left" will indicate this if properly placed, but mistakes have often been made in this procedure when the patient lies prone on the plate. Mistakes by clerks, assistants and helpers can be reduced to a minimum if a standard form of identification be made.

The following requisites are regarded as vital:

First. The identification should, in all instances, be exposed on the plate or film *with the part*—that is, it is a simultaneous exposure of both. It matters little where this identification be placed on the film, due regard being given for the anatomical shadows lest the marker interfere with the results, but unless contraindicated, it should routinely be placed in the upper right-hand corner.

Second. The marker should always be placed right side up, i.e., faced toward the tube target, whether the plate be horizontal, vertical or in any other position. If no exceptions be made to this rule, one can determine rights and lefts without other special marking. Thus the need of placing an opaque "R" or "L," or the word "right" or "left" can be properly dispensed with. This is regarded as particularly valuable in double-coated film exposures. Anteroposterior, posteroanterior and other direction of *x*-ray passage will also be evident if this procedure be used as a standard. The "front" or "face" of double-coated exposures is automatically established with 100 per cent definiteness.

Third. The identification should give the following indelible information, as illustrated in Figure 1:

1. Name of hospital or other institution in which the exposure is made. If not a diagnostic institution, this item is not necessary.

2. City in which the hospital is located. This is to distinguish one hospital from another of similar name, as, for instance, St. Lukes of New York from St. Luke Chicago.

3. Name of doctor-roentgenologist who is in charge of the *x*-ray department, and

who is responsible for the *x*-ray work and diagnosis.

4. The date on which the exposure is made. This is of prime importance when following the progress of a given case, for comparisons in medicolegal cases, etc.

5. The name of the patient (usually the last name suffices). Some names (particularly foreign ones) are of such length that the marker would have to be of considerable length; in such cases it can be shortened so as to give unmistakable letters establishing the particular patient exposed.

6. The name of the referring physician.

7. The serial number of the cases. (This is optional, but very convenient for office records, etc.)

There are several ways in which this identification can be done. A convenient way is to have a lead stencil made for those portions which are never changed, namely, the hospital or laboratory, the city and the roentgenologist's name. The date can be set up with small lead figures, placed on adhesive plaster, this being done but once a day. The other features, likewise, may be set up on adhesive plaster, using lead letters and figures. If many patients are examined, there is much delay in setting up all this information letter by letter and figure by figure; on this account one is loath to give the necessary time to the procedure. A search was made for a stencil machine which would provide this opaque marker quickly and easily. The one illustrated in Figure 2 has been found to give full satisfaction, and the stencil is quickly made. An alphabet and numerals provide all letters and figures. The stencil material used is the lead sheeting used in backing dental *x*-ray films. It can be obtained in 8-lb. rolls at a small cost. A roll of the material can be mounted on a suitable wooden axle support (easily constructed by the average technician) so that the heavy material can be reeled off in any length. A small photo trimming board is used to cut this material into 3-in. pieces; small-sized tinners' snips are also convenient. This stencil machine is equipped with a platform or stage built especially for the writer to accommodate this particular strip lead. Five separate lines of any length can be stenciled. After stenciling the marker, it is trimmed down to the smallest size possible so as to occupy a minimum of space on the exposure. This is invariably less than 2 × 3 in. in area. The time needed to make a complete stencil averages one minute. Figure 2 illustrates the stencil-perforator machine and the several parts used.

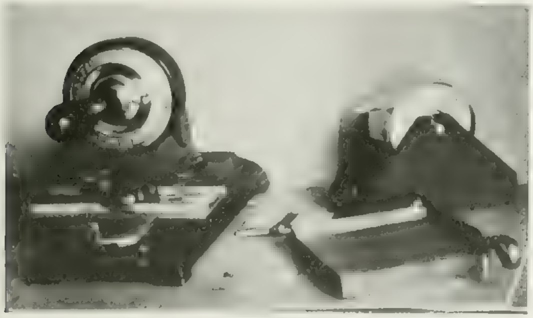


Fig. 2. Showing the stencil—perforator machine with special stage for the lead sheeting used in backing *x*-ray dental film; roll of lead mounted on support; trimming board.

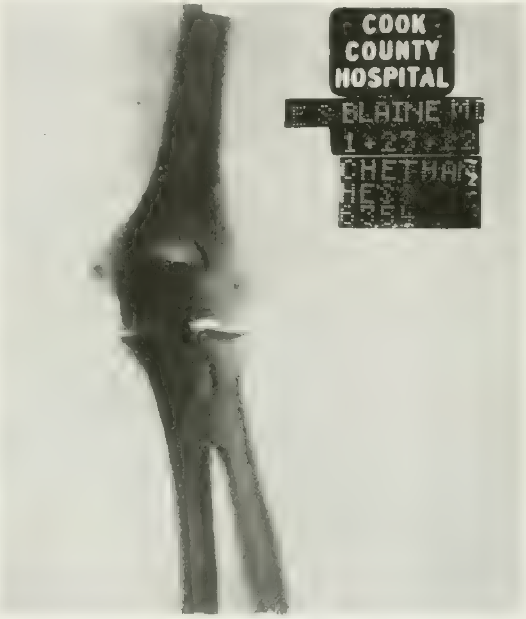


Fig. 3. Example of standard identification of *x*-ray exposure; simultaneous exposure.

In Figure 3 is seen the appearance of this form of exposure identification. An exception is made in this technique as applied to the exposures of the accessory sinuses of the head where border exposures add materially to the appearance of the film, as illustrated in Figure 4. In these cases the marker is exposed while exposing the border, which is always done immediately after each anatomical exposure. In justice to every patient, and in all fairness to the roentgen practice, the essayist believes that all exposures should be marked inerasably and indelibly, which will always prevent mistakes of assignment and preclude the possibility of substitution. Such identification as is here described can never be mistaken and films so marked can never be used for anyone else.

From the medicolegal standpoint, this form of identification is especially valuable, and of utmost importance, and the hope is here expressed that in the not far distant future every *x*-ray film or plate exposure placed in evidence in court procedure will be *required by law* to have unalterable and unmistakable identification along the lines herein set forth.

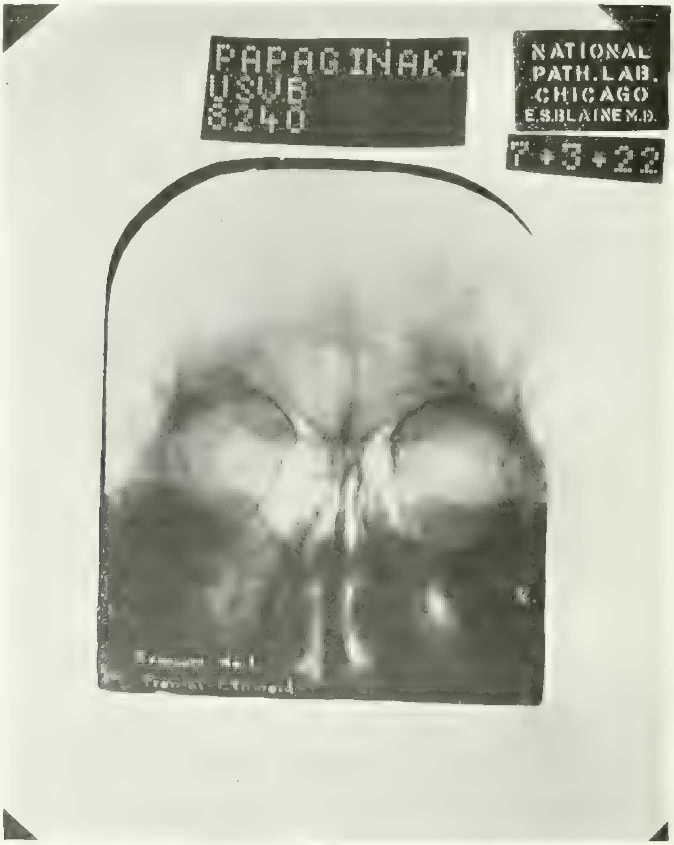


FIG. 4. Example of standard identification of *x*-ray exposure of sinuses; stencil exposed with border.

A BIOLOGICAL COEFFICIENT FOR THE ALUMINUM FILTER*

BY FRANCIS B. SHELDON, M.D.

FRESNO, CALIFORNIA

THIS paper is presented with the idea of demonstrating that the erythema dose may be predetermined, and of giving a method of determining that dose when using aluminum as a filter. In doing this, it will be shown that the formula of Prof. Shearer for the photographic plate applies also to the filtered dose. It will also be shown that the formula for filtered dose as given by Witherbee and Remer† cannot be used to any degree of accuracy to predetermine the erythema dosage.

In the use of a filter for the ordinary light there are certain principles that are always the same. For instance, if we place a red filter before the source of light, we will cut out all the rays but the red, and of those red rays there will be a certain amount lost through absorption of the filter. The amount of the red ray that will be absorbed will depend on several factors, namely, the intensity of the light at its source, the distance of the source from the receiving element, and the thickness of the filter. If we increase the thickness of the filter and at the same time retain the same intensity of the light at its source and the same distance of the source and receiving element, then the receiving element must of necessity receive less of the rays, for the filtering element will absorb the rays in a definite ratio to the thickness.

In the same way, if we increase or decrease the intensity of the light at its source, and do not change the thickness of the filter, the amount of the ray that will reach the receiving element will be increased or decreased in a definite ratio with the change in intensity. Furthermore, the per cent of the ray that the filter will absorb will have a definite ratio with the change in intensity. If we change the distance of the source from the receiving element, the effect of the ray on the receiving element will be in a definite ratio with this change.

With this in mind I gathered formulas that many different men were using in their treatment technique. Only those formulas that gave the spark-gap, milliamperage, time, distance, and number of millimeters of aluminum filter used, and only those in which aluminum was the only filter used, were selected. With such formulas the milliamperage and spark-gap represented the intensity of the light.

May I digress here long enough to say that most writers leave out one to three of these factors, and to my way of thinking their technique as published is of little value to their fellow workers. Most of the formulas gathered were found to vary in all their factors. Some used one spark-gap and some another, some used one distance and some another, some used one thickness of filter and some another.

Having gathered a number of these formulas, I then found the constants in accordance with Shearer's formula for the photographic film. To find a rough ratio for the filter the constants of the various formulas were divided by the number of millimeters of aluminum filter used in those formulas. It was found that this division gave quotients of 15 to 20, which was approximately, in each case, 15 plus 1/2 the number of millimeters of aluminum used in that formula.

A few of the formulas used:

$$\text{6 mm. Al.}\ \frac{5\text{ ma.} \times 12\text{ in. SG}^2 \times 12\text{ min.}}{8\text{ in. dist.}^2} = 135 \qquad 135/6 = 22\tfrac{1}{2}$$

$$\text{10 mm. Al.}\ \frac{5\text{ ma.} \times 12\text{ in. SG}^2 \times 40\text{ min.}}{12\text{ in. dist.}^2} = 200 \qquad 200/10 = 20$$

$$\text{3 mm. Al.}\ \frac{5\text{ ma.} \times 8\text{ in. SG}^2 \times 14\tfrac{1}{2}\text{ min.}}{10\text{ in. dist.}^2} = 46.4 \qquad 46.4/3 = 15\tfrac{1}{2}$$

$$\text{3 mm. Al.}\ \frac{5\text{ mm.} \times 9\text{ in. gap}^2 \times 12.8\text{ min.}}{10\text{ in. dist.}^2} = 51.8 \qquad 51.8/3 = 17.3$$

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion on this paper and others in the same symposium will appear in a later number of the JOURNAL.

† WITHERBEE, W. D., and REMER, J. Unfiltered and filtered *x*-ray dosage. AM. J. ROENTGENOL., Oct., 1920, vii, 485.

I then made up a formula for experimental use in which the constant should be always equal to the number of mm. of aluminum used as a filter times the equation $15 + \frac{1}{2}$ the number of mm. of aluminum used. Thus:

$$\frac{\text{ma.} \times \text{SG}^2 \times \text{T(in min.)}}{\text{dist. (in in.)}^2} = \text{no. mm. Al.} \left(15 + \frac{\text{no. mm. Al.}}{2}\right)$$

Usually it is the time factor that is sought, and with such a formula time is easily figured. Before beginning experimental work I thought to compare the time obtained with this formula and that obtained following the formula of Witherbee and Remer. First it was compared with their formulas when using 3 mm. of aluminum for filter. In this group of formulas they have kept constant the ma. dist. and filter; using in each case 5 ma. 10-in. dist. and 3 mm. Al. filter.

Chart I

Spark-gap	W. & R. Time	Time with Coefficient Formula
6 in.	26 min. 57 sec.	27 min. 50 sec.
7 in.	19 min. 48 sec.	20 min. 00 sec.
8 in.	14 min. 25 sec.	15 min. 30 sec.
9 in.	12 min. 50 sec.	12 min. 12 sec.
10 in.	11 min. 35 sec.	9 min. 54 sec.

The percentage of difference in these is not great and may be easily explained, for they first find the skin unit dose and then multiply this by 5 to 7 for their erythema dose. Now if they make a mistake of a few seconds only, in the reading of the pastille for the first skin unit, the erythema dose will then be at fault 5 to 7 times this few seconds. Witherbee and Remer use an arithmetical progression which varies with the spark-gap used and with the thickness of the filter. In the variation of the spark-gap they claim that anything below 6-in. gap requires 7 skin unit, or 7 times one skin unit dose for an erythema, and anything above 8-in. gap will require but 5 times the one skin unit dose. This appears to be purely arbitrary, or why should it not also change below 6 in. and above 8 in. of gap?

Not only does their arithmetical progression change with the spark-gap, but it also changes with the thickness of the filter, for they say that if 5, 6, or 7 mm. of aluminum filter is used with 8 to 10-in. spark-gap, then it only takes 3 times one skin unit dose for an erythema dose. They further state that each thickness of aluminum filter requires a separate standard or formula for one skin unit, and they have worked out a standard formula for each thickness of aluminum filter from ½ mm. to 7 mm.

Having compared the coefficient formula with theirs when using 3 mm. aluminum filter, I thought to compare the formulas when the thickness of the filter was changed. This was done with the following results:

Chart II

5 ma., 9-in. gap and 10-in. dist. are kept constant.

W. & R. Ratio of Advance	W. & R. Erythema Time in Min.	Al. Filter Mm. Thickness	Coefficient Formula Time in Min.	Coefficient Formula Ratio of Advance
	8.66	1	3.7	
3.0				4.2
	11.66	2	7.9	
1.16				4.3
	12.82	3	12.2	
7.16				4.6
	20.00	4	16.8	
1.00				4.8
	21.00	5	21.6	
0.00				5.0
	21.00	6½	26.66	
0.00				5.5
	21.00	7	32.1	

In the advancing of the time, when an additional millimeter of aluminum filter is added, you will note that with the formula of Witherbee and Remer, between 1 and 2 mm. there are 3 minutes. Between 2 and 3 mm. it is less than half this or 1.16 minutes. However, between 3 and 4 mm. of filter the time changes 7.16 minutes, which is 6 times as much as between 2 and 3 mm., and more than twice as much as the change from 1 to 2 mm. The next time that a mm. of aluminum filter is added there is another radical change in the difference of time. After reaching 5 mm. of aluminum filter there is then no further change. In other words, 5 mm. of aluminum filter offers as much protection as would 7. On the other hand, you will note that the rate of advance with the coefficient formula is uniform as each additional millimeter of aluminum filter is added, the difference each time being a little more than the former one.

Another thing I would have you note. The difference in time between 1 and 4 mm. of aluminum filter with the coefficient formula is 13.1 minutes, and with that of Witherbee and Remer it is 11.33 minutes. This difference is comparatively little, but why should the ray be so erratic in its time of producing an erythema when one or more millimeters of aluminum filter are changed within this range, as is expressed in the formula of Witherbee and Remer?

Having noted these figures and differences, and the further fact that the coefficient formula gave less time for the thinner filters than did that of Witherbee and Remer, I began very cautiously to experiment. After seeing the results I had more confidence in the coefficient filter formula. The skin reaction of the brunette being more than that of the blonde, the aim, in my experimental work, was to give such dosage as would barely show in the blonde and would give a slight tan in the brunette. This was always done on skin that had had no previous raying.

From these experimental dosages the following are taken:

1. Adult blonde was given 17 minutes' exposure using 2 mm. aluminum filter, 5 ma., 6-in. gap and 10-in. skin focal distance. Two weeks later there was a very slight color of the skin of the exposed area.

2. Adult blonde was given 6 minutes 57 seconds' exposure using 1 mm. aluminum filter, 6 ma., 6-in. gap, and 10-in. skin target distance. The exposed area was slightly reddened at the end of one week. This quickly disappeared.

3. That the law of the inverse square of the distance might be tested, a patient was given the following doses the same day, the distance and the time being the only factors changed: Two millimeters aluminum filter was used with 5 ma., and 10-in. spark-gap. The right side at 10-in. skin target distance was given 6 minutes 12 seconds' exposure and the left side at 8-in. distance was given 4 minutes 6 seconds' exposure. These areas were watched for several weeks and, so far as could be seen with the eye, there was no difference in the reactions of the two areas.

4. Adult blonde. Used 1 mm. aluminum filter, with 5 ma., and 10-in. spark-gap. The left side was given 3 minutes' exposure at 10-in. skin target distance, and the right side 6 minutes at 14-in. distance. To the eye there was no perceptible difference in the reactions of the two areas.

5. Adult blonde. A case of a very small hard skin tumor. I decided to give more than just a bare erythema. With 1 mm. of aluminum filter, 6 ma., 6-in. spark-gap, and 8-in. skin target distance, an exposure of 8 minutes was given. By the coefficient formula the time for an erythema dose is 4 minutes 22 seconds. I then gave nearly two erythema doses and got reddening of the skin that lasted more than six months. The formula of Witherbee and Remer would require 13 minutes 18 seconds for an erythema, or more than 50 per cent more than that given. There was no desquamation of the area.

6. Adult brunette. Used 4 mm. aluminum filter with 5 ma., 10-in. spark-gap. On the right side 8 minutes 42 seconds' exposure was given at 8-in. skin target distance. The same day on the left side 11 minutes' exposure was given at 9-in. distance. There was a slight browning of the areas. The right appeared to be a very little more than the left but the difference was so slight as to be hardly noticeable.

7. Adult brunette. Used 4 mm. aluminum filter with 5 ma., 10-in. spark-gap, and 12-in. skin target distance. An exposure of 20 minutes was given. This showed a slight browning.

8. Adult brunette. Used 4 mm. aluminum filter with 5 ma., 10-in. spark-gap, 15-in. distance, and 30 minutes' exposure. The area was slightly discolored for a few weeks only.

I have used this formula with many different patients, varying all the different factors, and in so far as the eye can determine, the reactions appear to be very nearly the same for all. Furthermore, a

75 per cent erythema dose, as determined by the aluminum filter coefficient, when given on the scalp, will produce a temporary alopecia. This has been done several times when treating brain tumors.

In all this work I have used a machine with the cross arm type of rectification. The spark-gap has been measured with small spheres instead of points. All machines do not give the same output of energy, nor does the same machine when moved from one place to another always give the same output with the same setting of the filament control and auto transformer. Then, too, one man may want a gap distance that will just break and another may want a flame. However, the laws of physics work uniformly with all machines, and having once checked the erythema dose for a machine with a given thickness of filter we should be able to change any of the factors of that dose and still calculate the time of the erythema dosage with the new or changed factors. It may be that this filter coefficient will work with many machines and it may be that others will have to use a different coefficient.

My work has all been done with the aluminum filter, and when using any other material for filtering some other equation must be used. I am convinced that the formula of Shearer together with a filter coefficient can be used to predetermine accurately the erythema skin dose.

I have used this filter coefficient formula for eighteen months and am pleased with the results obtained.

BOOK REVIEWS

RÖNTGENOLOGISCHE STUDIEN ÜBER DEN BULBUS DUODENI. (ROENTGENOLOGICAL STUDIES OF THE DUODENAL BULB. Åke Åkerlund, Stockholm, 1921.)

This book represents probably the most intensive radiographic study of duodenal ulcer of today. The author begins with a thorough survey of the anatomy of the duodenum, as a basis for the determination of the pathological changes incident to an ulcer in this portion of the gut. He includes a description of personally investigated pathological specimens which have been hardened *in situ*. He, further, in discussing the technique of radiography of the duodenum, describes his apparatus, which permits of the taking of serial radiograms in the upright position, and offers the advantage of more readily and completely visualizing the duodenal cap without its being covered by the pyloric end of the stomach, as so frequently is the case in the prone position. He analyzes the deformity of the bulb, not as we are wont to do grossly, but rather analyzing the various component alterations of contour that enter into the picture of a duodenal ulcer. In this way, he designates the defect in the light of niche formation, indentation of the opposite curvature, retraction of the musculature adjacent to the site of the ulcer, and the pseudo-diverticuli which may be induced by spastic contraction of the first portion of the duodenum. In his discussion, the author reviews the pertinent radiological literature, critically analyzing as he goes.

A statistical survey of 109 cases with complete roentgenological observation plus clinical course and operative or autopsy findings is included. This serves to confirm the roentgenological or to elucidate the *x*-ray findings. The book merits attention of both the radiographer and the gastroenterologist, for it permits of a more accurate understanding of the various bulb defects that are noted in duodenal ulcer.

A. L. LOURIA.

NOUVEAU TRAITÈ DE MEDECINE. FASCICULE V. MALADIES INFECTIEUSES ET PARASITAIRES. LE CANCER. By G. H. Roger, Fernand Widal, and P. J. Teissier. Sixth edition. Paris, 1922.

This volume of 750 pages is of greatest interest to the radiotherapist, for more than half the book is devoted to a discussion of cancer. This section is written by Roussy, associate professor, and Wolf, assistant chief of clinic, to the Faculty of Medicine of Paris. There is also a long discussion devoted to cancer in animals, to experimental cancer, and to the pathological anatomy of cancer. The final hundred pages take up the therapeutics and prevention of cancer. The section on radiotherapeutics of cancer is written by Madame Simone Labord.

A NEW DEVICE FOR RETUBING RADIUM EMANATION

BY WILHELM STENSTROEM, PH.D.

Physicist to the State Institute for the Study of Malignant Disease

BUFFALO, NEW YORK

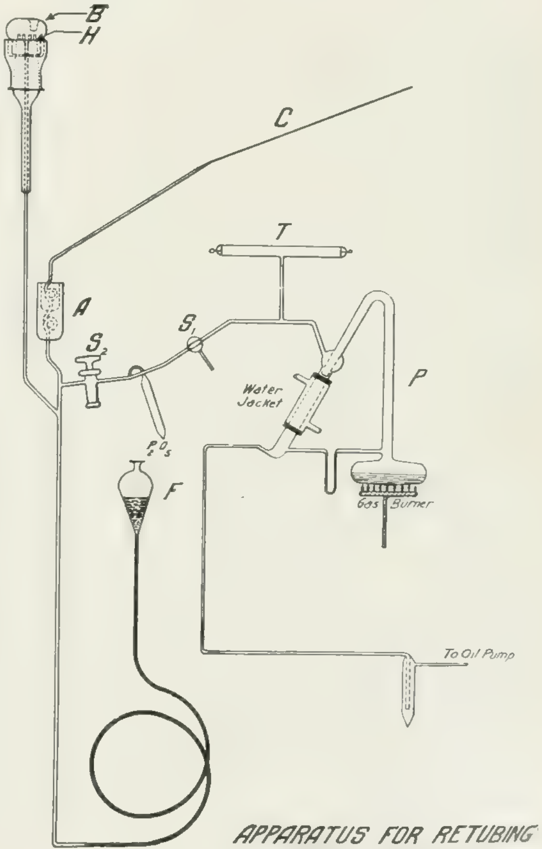
RADIUM emanation disintegrates quite rapidly, half of a given amount disappearing in 3.8 days. If only the ordinary apparatus is used for pumping off the emanation from the radium solution, there will be just some few strong tubes and a great number of weak ones. For instance, with two grams of radium, a probable distribution would be: 6 tubes with more than 100 mc. emanation each; 8 tubes with 50 to 100; 10 tubes with 20 to 50; 20 tubes with 4 to 20; and, of course, an indefinite number of weaker ones, their strength depending upon the time of removal.

Strong tubes are more useful than weak ones, as a rule. The weak ones could, of course, be injected into the tissue. It is, however, preferable to make such tubes (seeds) from a much finer capillary tubing. It is, therefore, of advantage to have an apparatus by means of which the emanation can be concentrated from a number of weak tubes into a strong one, or into finer tubes, or into a bulb.

I am going to describe such an apparatus of simple construction which has been in use for a short time at the State Institute in Buffalo:

The emanation is concentrated with the aid of liquid air, and therefore can be freed from air, which is of great importance, as the main emanation plant is of the Duane type. It sometimes happens that, accidentally, air gets into this apparatus. The emanation, upon such occasions, cannot be concentrated enough there, but usually can be collected in a number of big tubes. With the retubing apparatus the air can be abstracted and the emanation concentrated into the required volume.

The retubing apparatus is shown in the drawing to which the letters refer. The old emanation tubes are put in a series of small cups on top of the holder H. The glass cap B is ground to fit closely over H, and to the inside of B is attached a little lug, which will break the tubes one after the other, when B is turned around. The whole system is evacuated with the Langmuir pump P, and the same oil pump which belongs to the other emanation apparatus. The vacuum is determined by the discharge of a little induction coil through the Geissler tube T. Water is absorbed by the Phosphorous-Pentoxide tube P_2O_5. The emanation is condensed in the spiral part of the glass tubing which passes through the liquid air container A. (This arrangement for the condensation has been introduced by Mr. Fred West at Johns Hopkins Cancer Hospital, Baltimore.)



APPARATUS FOR RETUBING RADIUM EMANATION

The emanation is forced into the capillary tube C by raising the mercury flask F and thereby the mercury inside the tube. The apparatus is as simple as possible; only two stopcocks are needed, one single-way mercury stopcock S_2, and one double-way grease stopcock S_1. The Langmuir pump takes care of all the pumping, and the mercury has to be raised only once. All parts have been made by our glass blower.

PRINCIPLES OF RADIOTHERAPY OF CARCINOMATA ESPECIALLY OF UTERINE AND MAMMARY CARCINOMATA*

BY PROF. DR. E. OPITZ

FREIBURG, I. B., GERMANY

If we desire to improve the therapeutic results of uterine and mammary carcinomata, we must critically investigate those cases which have been treated successfully, and describe the methods which yielded the desired results. We have studied cases of carcinomata which have been irradiated in our gynecological clinic up to six years ago.

Subjecting the results to a careful analysis, we are at once confronted with the difficulty that we do not possess reliable records of the doses employed in the cases treated during that time. The cases in question represent the first attempts by Kroenig at treating cancer by means of radium and *x*-rays.

At that time, a correct knowledge of the exact dosation of radium or *x*-rays was not available, and the records of dosage in the histories had therefore been omitted. Nevertheless, it was possible to obtain an approximate idea of the quantities of rays employed from the statement of the occurrence or nonoccurrence of a skin erythema and the arrangement of the radiation capsules and *x*-ray tubes.

We were not greatly surprised when we found that cases showing a cure of five or more years' duration manifested none or only a slight erythema after the irradiation. On the other hand, in all those cases in which an erythema or a burn of a second or third degree was observed, a relapse occurred in a very short time. The recurrence took place earliest in cases in which the burns were extensive. This observation appeared to be quite startling. The cases in question were clinically of an analogous character, having been selected by Kroenig for this very reason.

From the literature, as well as from my own observation, I want to report a series of data which will enable us to draw certain conclusions.

First, I shall refer to those irradiations which were employed for the prevention of recurrences in cases of mammary carcinoma. The cases irradiated by Perthes showed the very remarkable result that relapses became not only not less frequent, but even more frequent than after operation without subsequent irradiation. In contrast to this, Anschütz's cases of mammary amputation with subsequent irradiation showed a reduction in recurrences which hitherto had never and nowhere been obtained.

The methods of irradiation of these investigators were not the same, Perthes employing comparatively large doses which approximated the so-called "carcinoma dose" while Anschütz used smaller doses frequently repeated.

The following is another noteworthy fact: Perthes reports a case in which the irradiation of skin recurrences after a mammary amputation for carcinoma produced a roentgen ulcer which at first remained stationary. A diagnostic excision revealed the presence of cancerous cells. Subsequently, the parts adjacent to the place of the diagnostic excision showed a rapid proliferation, while the cancerous nodules present in the neighborhood remained unchanged for a considerable length of time. We made a similar observation. A woman who had been successfully irradiated for an inoperable carcinoma of the stomach became afflicted with an ulcer in the skin above the irradiated gastric carcinoma five years after irradiation. The skin had been indurated and leather-like. A diagnostic excision was made. It was followed by a surprising result. The tumor increased rapidly and showed fungoid proliferations which proved to be of a carcinomatous nature. After a short period of time, we observed a perforation of the stomach and transverse colon which gradually increased and finally led to a fatal termination.

---

* Read by title at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922. Discussion on this paper and others in the same symposium will appear in a later number of the Journal.

In this connection I desire to add two quite remarkable observations. A woman with an irradiated vulvar carcinoma became afflicted with a hard tumor in the posterior part of the left labium minus, which, on inspection and palpation, appeared to be benign. The tumor bore the appearance of, and resembled, on palpation, a fibroma pendulum, while the carcinoma had disappeared completely. The tumor was removed. It proved to be a solid carcinoma, apparently, with a very slight tendency to proliferation. The growth was separated from the healthy tissue by a thick wall of lymphocytes. Quite recently we made a similar observation in another vulvar carcinoma.

The following observations have been made quite frequently. Some time ago, in sections of tissue removed after radiation for uterine carcinoma, Haendly found active and apparently proliferating cancer foci in the completely necrotic tissue. A similar observation has been reported by Eckelt (Gynecological Clinic of Frankfurt). Perthes' observation, cited above, also belongs to this class of cases. Many similar cases are on record.

In summarizing the results of these observations, we may be justified in drawing the following conclusions: The destruction of the carcinoma by means of irradiation is by no means accomplished in all, and even not in the majority of cases. The carcinoma may recede, but cancer-cells, perhaps microscopically not recognizable, remain behind. Their capability to grow and to multiply may be destroyed for a longer or shorter period of time, but by no means permanently. Certain stimuli, or perhaps, the lapse of time, may engender a renewed proliferation of the cancer-cells. Such stimuli are mechanical traumata, as diagnostic excision or incorrect irradiation. The latter assumption may explain the puzzling fact that Perthes has observed more recurrences after operation and subsequent irradiation than after operation without subsequent irradiation. One must surmise that cancer germs were left behind after the operation which might have been destroyed by the tissue itself, but were stimulated to renewed proliferation by the irradiation. This explanation might be surprising to most of us. We regard as correct the claim that cancer-cells may be devoured by the organism under ordinary conditions. It is quite certain that in the large majority of cases, cancer-cells are regularly carried off in the lymph and blood streams, but only a few of them develop into necrotic carcinomatous growths. In my opinion, this can only be explained by the fact that the normal tissue, especially the blood and lymph-cells, is capable of destroying solitary migrating cancer-cells.

A further deduction which we may draw from these observations is the fact, repeatedly mentioned by me, that too large a dose of radium or *x*-rays is at least as harmful as too small a dose.

Yet, with the mere reiteration of these facts, we have gained very little, if anything, in our endeavor to improve the curative results. First of all, we must determine the manner in which the rays influence the cancer and the facts on which the curative action of the rays is to be based. In short, we must study the biology of the action of the rays. We have endeavored for some time to fathom these biological laws.

Numerous observations justify the statement that a complete cure of cancer has been achieved by the sole use of radiation, yet in the majority of cases such a result has not been obtained. In the cases cited above, it has been shown that the best curative results were obtained with repeated irradiations in which the so-called "carcinoma dose" as defined by Seitz and Wintz, was not attained. If the latter lies between 90 and 100 per cent of the "erythema skin dose," we must admit that in our cured cases of mammary and uterine carcinomata, which are situated deep in the body, the tumor received less than 90 per cent of the "erythema skin dose," at least in its deeper parts, if we did not attain an erythema of the skin by the irradiation. Nevertheless, in all these cases the cure was permanent.

The state of affairs is somewhat more confusing in the postoperative irradiations performed by Anschütz. He never attained a radiation dose that amounted to a carcinoma dose, even if the rays were applied in several repeated courses of radiations. It follows that cancer cases were cured which never did receive the "carcinoma dose."

In direct contrast to these facts, we have seen that the employment of quantities of rays which considerably exceed the "carcinoma dose" in some cases even caused necrosis of the connective tissue, and in others, at least an intense inflammation did not result in a cure. It follows that it should not be the sole object of radiation therapy to apply a quantity of rays as large as possible to the cancer-cells, as then the presence of viable cancer-cells in the necrotized connective tissue would be unthinkable.

The majority of authors explain the action of rays by saying that a sufficiently intense radiation causes quite characteristic changes in the cancer-cells. The latter recede either completely, or, at least, to a marked degree. They further assert that cancer-cells perish when the functions of nutrition and division have been severely impaired by the direct action of the electro-magnetic waves.

It should not be at all disputed that such effects of the rays are possible, and actually occur. It would be unreasonable to assume that cancer-cells should behave differently than other tissue cells which all can be changed or destroyed by the rays, depending, of course, on the amount of rays administered. But according to the observations just mentioned, the matter cannot thus be explained, and the coexistence of other factors must be assumed. These are to be found in the activation of the defensive forces which are formed in the neighboring tissues as well as elsewhere in the body by the action of the rays. It is well known that after a certain time, mostly after the commencement of recognizable changes in the carcinoma, serous infiltration and proliferative processes may be observed in the connective tissue which undoubtedly contribute to the disappearance of the cancer-cells. I believe these facts are of great importance in the results of radiation therapy in carcinoma. The participation of the connective tissue receives at present more and more attention. I refer to Halberstädter, Blumenthal, Theilhaber, M. Fränkel and others. The changes in the white blood picture are to be valued in a similar manner. Nothing definite is at present known regarding the manner in which these changes contribute to the destruction of the carcinoma. Recently, Lewin has called attention to the rôle played by the white blood-cells in the disappearance of inoculation tumors in mice. If he subjected mice to treatment with nucleic acid before the inoculation of tumor substance, the latter did not take but underwent destruction. It was permeated with numerous lymphocytes and surrounded by a connective-tissue proliferation.

Caspari has reported similar observations which, however, are not as yet available in detail in the literature, but in brief abstracts. A number of years ago, I pointed out that the lymphocytes play an important rôle in the warfare against the carcinoma. Of late, Ribbert, Theilhaber and others have expressed similar views. Accordingly, the proliferations of the connective tissue, and particularly the infiltration of numerous round cells, which are to be found around almost all of the carcinomata, are to be regarded as defensive agents. As a matter of fact, in the majority of instances they do not serve the purpose. I would like to emphasize the fact that in the large majority of cases, and sometimes almost exclusively, these round cells are mononuclear and that the leucocytes play but a minor rôle. Furthermore, it must be noted that the destruction of wandering cancer-cells in the lymphatic glands has been positively demonstrated, and consequently the lymphocytes can under favorable conditions gain the upper hand in the combat with active carcinoma cells.

Recent observations made with vital stains, and to be published shortly, have brought up the question whether these mononuclear cells, hitherto taken for lymphocytes, are not to be considered as histiocytes instead of as lymphocytes. Whatever the character of the cells may be, they do assume an important rôle in the warfare of the organism against the carcinoma. My belief in the aforesaid deductions is strengthened by the especially intense infiltration of round cells seen in the slowly proliferating carcinoma rests after irradiations.

It is well known that the lymphocytes are the most sensitive to the rays. Large numbers of them already succumb to small radiation doses. If this is correct, then all the round cells normally surrounding the carcinoma are destroyed during each irradiation of a carcinoma by the doses administered. They, therefore, are disintegrated *in situ*. The liberated proteins of the round cells and the peripheral carcinoma cells are thrown into the tissues. To me it seems highly probable that these split-up proteins contribute an essential rôle in the destruction of the carcinoma cells.

I am not yet in a position to furnish a direct proof for the correctness of this hypothesis. Such investigations meet with great difficulties. They are being actively undertaken, but I cannot as yet make any definite statements as to the final results. The early occurrence of the changes in the cancer-cells might be explained, and also the observation correctly interpreted why intensive irradiations fail to produce the desired results and, on the contrary, excite the cancer to limitless proliferation. It is well possible that a too intensive irradiation may destroy the defensive material furnished by the lymphocytes. Further, too intense an irradiation may lead to a general impairment of the body, which weakens the hematopoietic organs and impedes the further supply of lymphocytes. The strongest activating forces for the production of new lymphocytes may be found in the absorption of the disintegration products of the lymphocytes by organs forming the white blood corpuscles. If this activating factor exceeds a certain limit, it may lead to weakening instead of a stimulation of their production.

This conception also furnishes the explanation for the observation that cachectic patients do not respond to irradiation, for cachectic patients evince an absence or a scarcity of lymphocytes and leucocytes in the blood, and an incapability to respond to stimulation. Therefore, Recasens excludes from irradiation cachectic patients and those affected with leucopenia.

These changes in the lymphocytes represent only part of the effects produced by irradiation. We know that various other effects are produced by irradiation, and these may be comprised under the name "general or systemic effect." They are plainly observable in the changes occurring in the white blood picture. The red blood corpuscles also undergo changes. A change in the blood coagulability does generally not take place, and, according to our observations, only if the spleen is irradiated directly. Partsch has made similar observations. It is quite surprising that in a large proportion of cases, irradiation is immediately followed by an increased blood pressure. This is probably due to a stimulation of the suprarenal capsule, particularly of its cortex. Investigations conducted by Hesse, and not yet published, show that direct irradiation of the suprarenal capsule is followed by its quick destruction and a considerable diminution of the vasoconstricting power of its extract.

Stephan has recently published similar observations made on human subjects. I induced Sickinger to make experiments on guinea-pigs, and he demonstrated that following the irradiation of an equally large field on the head and the tail-end as well as the middle of the body, the changes in the blood picture were most marked in the latter. It seems to me that irradiation of parts remote from the suprarenal capsule exercises an exciting effect upon this sensitive organ, and that the excitation may be produced either via the bloodstream, or, perhaps, be due to a weak secondary irradiation. Furthermore, it has been demonstrated by Behne that blood transfusion from an irradiated to a non-irradiated animal causes the same blood changes in the latter as produced by direct irradiation. Therefore we must assume that a general systemic action is produced by the rays which, in favorable cases, may promote the cure of cancer.

The general effect comprises not only the conditions just mentioned, but also applies to others. Kaznelson and Dourand demonstrated that quite similar effects to those seen in the so-called protoplasm activation may also be due to the effects of irradiation. This would be in favor of the view that irradiation implies a kind of excitation, and, provided the proper dose is administered, an increase in the defensive forces of the organism, for the cure of cancer is to be regarded as the outcome of a combat between the invading "parasitic" cancer-cells and the body.

We were in the position to furnish also an experimental proof of the favorable action of the constitutional reaction. If we irradiate mice, either with large doses on a small field, or totally, then, after a certain dose has been reached, the healthy non-inoculated animals will succumb after from three to seven days, and, in the majority of instances, already on the third day after irradiation. But if the animals are inoculated with a tumor emulsion sometime before the third day, they will live. In the majority of cases, successful growth of the tumor which possesses a positive take of 100 per cent, will be prevented. This shows that (1) the toxins which are produced in the body as the result of irradiation are agglutinated by inoculated carcinoma cells, and (2) that this agglutination engenders an impairment of the carcinoma cells, or, at least, renders more difficult their growth.

Moreover, we have seen that peculiar and quite typical changes also take place in the non-irradiated cutaneous tissue of mice, as early as a few hours after irradiation. They consist especially in the appearance of large cells in the skin, serous swelling of the entire connective-tissue, and degenerative processes in the cutaneous glands. All these changes take place with a surprising rapidity. In my opinion, one should not *a priori* reject the supposition that the changes observed in the carcinoma cells are, at least partly, due to those produced by irradiation in the whole organism.

Experiments were made in order to ascertain the influence exercised upon carcinomatous tissues outside of the body. So far, we never succeeded in proving the loss of the transplantability of carcinoma cells by inoculation through direct irradiation with a dose exceeding the so-called "carcinoma dose." These experiments agree with those of Keyser, but are contrary to Wood and Prime's observations, which are based on numerous animal experiments. This question, therefore, needs further elucidation. Such contradictory findings are possibly due to a difference in carcinoma material. However, by accidental experiments on human beings the fact has been established that irradiation doses which destroy connective tissue may spare active cancer-cells.

A carcinoma dose as propounded by Seitz and Wintz does not exist. We agree with Werner, Jüngling, Wend and others, and cannot admit that a dose which lies between 90 and 110 per cent of the erythema skin dose will regularly induce a retrogression or cure of the carcinoma. Even for uterine and mammary carcinomata, which, excepting the cutaneous carcinomata, offer the most favorable conditions for the irradiation treatment, a dose in this sense cannot be admitted. Carcinomata in other localities, which differ histologically and biologically from the uterine and mammary carcinomata, also respond quite differently to irradiation.

The location of the tumor is of the utmost importance in the various forms of cancer. If we irradiate a uterine or mammary carcinoma, none of the important endocrine glands are exposed to the action of the rays; but, in cases of cancer of the stomach it can never be avoided—not even with the method of Hohlfelder—that the suprarenal glands, the pancreas and the spleen, receive large quantities of rays. It is not necessary that the organs are directly struck by the cone of rays. For tissues as sensitive as the suprarenal capsule, the secondary irradiation, which is abundantly present just outside the periphery of the cone of rays, is harmful, especially since its effects must be added to the general effect.

Our observations suggest still another

conclusion, namely, the ideal of a permanent destruction of the carcinoma by one strong irradiation can be realized only in a few cases. Therefore, we believe it is better to employ frequent and small doses than an intense irradiation in one sitting, lest a violent general reaction and an impairment of the connective tissue adjoining the carcinoma thwart the curative effect.

Besides the above-mentioned facts regarding irradiation of the carcinoma, the following points are of the utmost importance for practical purposes:

First, the question of dosage. The general tendency prevails today to regard as a dose only that quantity of rays which is applied to the seat of the disease. I contend that this view is fundamentally wrong. In measuring the dose, we must take account of the entire energy of the rays absorbed by the irradiated body. The fact that this contention has almost always been overlooked explains a large number of failures. In studying this question experimentally, we were able to show that mice which bore on a limited skin area a radiation dose up to 490 e would succumb if the whole body was irradiated with a dose of 50 e, and only a few mice survived a dose of 25 e, while mice already inoculated with carcinoma were generally able to endure such doses. This shows the strong influence of the "general action" upon the animal, and also the influence of the effect of the rays in relation to the particular state of health of the animal.

Furthermore, in the mouse, a retrogression of the carcinoma cannot be effected, not even with doses which reach the limit of the animal's endurance, if the irradiation is restricted to the tumor itself. Retrogressive processes can only be obtained when a larger field is selected, so that also the parts surrounding the tumor are exposed to the rays.

The topographical relations also have to be taken into consideration. If we irradiate the extremities, the effect will be different from that following the irradiation of the trunk. Also, with an equally irradiated volume (as shown in experiments with guinea-pigs), an equally large field at the head and tail-end will show a smaller influence upon the blood picture than irradiation of the middle of the body, near the suprarenal capsule (Sickinger). From this we conclude that the action upon the endocrine glands, especially the pancreas, spleen, liver, thyroid, thymus and the intestines is not without influence upon the effect of the rays.

Furthermore, differences are caused by the quality and also the quantity of the radiation. The question remains open whether the short-wave rays obtained from radium and mesothorium will, with an equal dose, produce the same effect as the long-wave rays produced with the highest voltages and strongest filtration as at present used by our foremost roentgenologists.

I must be satisfied with these brief remarks. The problem is exceedingly intricate, and will later be more fully discussed in detail. At any rate, we know absolutely that the size of the field, the focus-skin distance, the hardness of the ray, radium or mesothorium or *x*-rays, and the method of their application explain the great differences in the local as well as the general effect reported in the literature. The reports on the action of rays issued by different authors can frequently not be compared with one another.

If it is true that with a single irradiation and correct dose the cancer-cells are not completely destroyed, but that a number of them remain in an inactive state, then two ways are open to change the mere arrest of the carcinoma to a complete cure: namely, (1) the subsequent destruction of the remaining cancer-cells or (2) the activation of the body so that it will be able to destroy the cancer-cells or furnish an unfavorable soil for any further growth of the carcinoma. The latter possibility is inferable from the fact that there is evidently a carcinomatous diathesis as suggested by Theilhaber, who separates the "cancer disease" from the local manifestations of cancerous proliferation. For both conceptions many methods are available. The complete destruction of the cancer-cells may be attempted by repeated irradiations. The second aim may be brought about by a stimulation of the connective tissue, a restoration and reactivation of the bodily vigor, a stimulation of the lymphocytosis, an excitation of certain endocrine glands, special methods of diet, a hyperemization of the scar tissue formed after irradiation, a surgical intervention, and many other methods. Both are often intimately related with or supplement each other. These few suggestions must suffice, for we have at our disposal a great number of possibilities. In the opinion of some observers, the sensibilization of the carcinoma prior to irradiation has often been successful.

Volz's recent investigations have verified the theory enunciated by me long ago: namely, that the sensibility of a tissue to the action of the rays depends to a large extent on its actual condition. By the incitation of certain influences we undoubtedly can raise or lower the sensibility to the action of the rays. The latter has actually been effected by anemization of the skin. Hyperemization raises the sensibility—a fact which may be utilized in the irradiation of a carcinoma. Little hope can be based on the introduction of secondary rays with the view of enhancing the effect of irradiation. Friedrich and his co-laborers have experimentally proven that an increase of the secondary rays by the introduction of iodine, metal salts, and similar radiators, does not increase, but on the contrary, decreases the quantity of rays. The decrease depends on the concentration of the solution and amount of the secondary radiator. Therefore, we cannot expect any success, at least not in this direction, from the introduction of metal salts by diaphoresis (copperization—Wintz-Seitz). However, by catalyptic or other activating effects upon the biologic object, the action of the rays may be increased. The assertion that we are dealing with an increased secondary irradiation, therefore, is erroneous. If really an increase in the action of the rays has been attained by the introduction of metal salts, etc., this increase is to be ascribed to the sensibilization through diaphoresis, which might as well be obtained by diathermy or mechanical and thermic hyperemization.

We have pointed out repeatedly that the condition of the patient is of great importance. In case of a pronounced cachexia, neither the skin nor the tumor will respond to irradiation. To a large extent, this phenomenon may be due to the frequently observed leucopenia, as suggested by Recasens, though it is certainly not the only cause. At any rate, it is useless to employ irradiation in obviously cachectic subjects, as, by this procedure, we would achieve nothing but the hastening of death.

In an intelligent *x*-ray treatment we must, first of all, aim at the relief of the cachexia, which, in some cases, may be successfully accomplished by suppression of the ichorous discharge and stimulation of the organisms by internal remedies (e.g., arsenical iron, protoplasma activation, blood transfusion, etc.). However, in such desperate cases, we frequently must be satisfied to alleviate the patient's suffering by the employment of the above-mentioned remedies, combined with cautiously repeated irradiations. Thus a tolerable condition can be procured and the patient's life prolonged.

In this kind of treatment we must distinguish between two things: (1) an antitoxic effect upon the body, as frequently observed in animal experiments. By the employment of certain therapeutic methods it is possible to reduce the influence of the tumor on the host to such a degree that tumors of an enormous size may become of negligible importance, though untreated animals may succumb to considerably smaller tumors. (2) The immediate effect upon the tumor itself, the arrest of its growth, and its eventual destruction.

These observations draw our attention to the subject of immunity. It has been proven beyond the shadow of a doubt that a sort of immunity against tumors is observed in animal experiments. I wish to refer briefly to the investigations of Jensen, Ehrlich, Gaylord, Cowes, Apoland, von Dungern, Baishford, Königsfeld, Keyser, and many others. I performed such experiments with animals as well as human subjects in 1900 and the following years. In a case of inoperable rectal carcinoma, I observed a retrogression lasting at least two years which was induced by passive immunization. Unfortunately, I could not follow up the case longer than two years. I do not have the least doubt that there is an active as well as a passive immunity against tumors. Whether the facts agree with Lewin's recent statements to the effect that we are merely dealing with a question of the white blood picture, seems to be doubtful. I do believe that besides the general predisposition, a protective force against the formation of tumor and tumor transplantation, i.e., a specific immunity, exists. We have begun new investigations in this direction. We cannot as yet report the findings. We should not overlook this possibility when raying patients. Active immunization processes in the breaking down of the carcinoma under the influence of the rays are of great importance for permanent results.

We have already drawn practical conclusions from these researches of radiation therapy, embodied them in the technique and observed the most pleasing results. We meet but few cases of uterine and mammary carcinomata in which we fail to bring about an immediate retrogression by our irradiation methods, supplemented by all possible accessory methods, without ever observing any permanent injuries, such as skin burns, the formation of fistulas, etc.

We proceed in the following manner: Each case is submitted to the most careful examination; site and extension of the tumors are ascertained with the aid of schematic diagrams and then the irradiation program is drawn up. In uterine carcinoma we always use radium rays supplemented by *x*-rays; in mammary carcinomata we generally employ only roentgen rays. The ideal to destroy completely the carcinoma by means of a single irradiation must be considered as unattainable, with the exception of a few incipient and especially favorable cases. We give frequent irradiations at intervals of from six to eight weeks with doses which, at least with roentgen rays, never reach the so-called "carcinoma dose."

Stimulating irradiations of thymus and spleen, likewise at repeated sittings, are employed as adjuvants. Also the use of caseosan, blood transfusion, arsenical iron, hyperemization of the irradiation area, and immunization.

The method of treatment may be summarized in the following rules:

1. Retrogression of the cancer is not solely due to the local action of the rays, but it is to be considered as a function of the whole organism that has been attacked by cancer. The organism is activated by the irradiation.

2. The elements of these activating forces are contained in the healthy tissues surrounding the cancer, the blood, and probably also the endocrine glands, including the spleen (reticular-epithelial apparatus).

3. A "carcinoma dose" according to the definition of Seitz and Wintz, that is to say, a curative action upon every variety of cancer by a dose of rays of from 90 to 100 per cent of the erythema skin dose, does not exist. However, in the majority of cases of mammary and uterine cancers a retrogression may be expected from the administration of this dose (Holzknecht). This carcinoma dose proposed by Kroenig is therefore still useful.

4. Experience teaches that frequently repeated irradiations with a dose which does not quite reach the amount of the carcinoma dose are productive of the best permanent results. The most favorable results are observed from a combination of radium and *x*-rays.

5. An over-dosation is to be considered as especially dangerous because it weakens the local as well as the general defensive forces of the body.

6. The posological question requires an elucidation on account of the systemic action of the rays.

7. The therapeutic effects of irradiation can be augmented by the employment of various auxiliary remedies.

8. The best results are only obtainable if the method of irradiation is adjusted to the particular conditions of each individual case.

CONCERNING A NEW KIND OF RAY*

BY W. C. ROENTGEN

MUNICH, GERMANY

Translated from the German By Ethel R. Jackson for

The American Journal of Roentgenology and Radium Therapy

Preliminary Report

If a Hittorf vacuum tube, a Lenard tube pumped sufficiently high, a Crookes tube, or a similar apparatus is covered with a rather closely-fitting shell of thin black pasteboard, if then the current from a rather large induction coil is sent through this tube, and if a paper screen covered with barium platino-cyanide is brought near the tube in a completely darkened room, the screen will be seen to light up brilliantly and to fluoresce, regardless of whether the coated side or the other side is turned toward the apparatus.

It is easily proved that the cause of the fluorescence has its source in the tube and in no other place.

2. Most surprising in this phenomenon is the fact that some agent penetrates a black pasteboard shell, which does not allow passage of visible or ultraviolet rays of the sun or of the electric arc, and that this agent can cause brilliant fluorescence. The next question is whether other bodies possess the same property: i.e., are transparent to this agent.

It soon becomes evident that all other bodies are transparent, but in greatly varying degrees. For example, paper is very transparent.[1] Behind a bound book of about 1000 pages, I saw the screen light up distinctly, the black ink of the print apparently offering no resistance. In the same way the screen lit up behind a double pack of cards. The effect of a single card between the apparatus and the screen could hardly be noted by the eye. Also, one piece of tinfoil had little appreciable effect; and only when several layers were placed one on top of another could a shadow be distinctly seen on the screen. Thick blocks of wood are transparent. Two to three centimeters of pine wood absorbed very little. A layer of aluminum 15 cm. thick weakened the effect very much, but was not sufficient to efface entirely the fluorescence. Hard rubber discs, even several centimeters thick, were transparent to the rays.[2] Glass plates of the same thickness differed according to whether they contained lead (flint glass) or not, the former being much less transparent than the latter. If one holds his hand between the tube and the screen, he sees the darker shadows of the bones in the lighter shadow of the hand itself. Water, carbondisulphide and various other liquids experimented upon in mica vessels proved to be very transparent. I could not discover that hydrogen was more transparent than air. A fluorescence could still be distinctly noted behind plates of copper, silver, lead, gold and platinum, but only when the layer was not too thick. Platinum 0.2 mm. thick is still transparent; silver and copper can be thicker. Lead 1.5 mm. thick is as good as impenetrable, and was used repeatedly on account of this property. A stick of wood with a square cross section (20 × 20), one side of which was covered with white lead, produced the following result when held between the tube and the screen: It was almost entirely ineffective when the *x*-rays passed through parallel to the treated side, but it threw a dark shadow when the rays had to penetrate the white lead. The salts and solutions of the metals follow the same order as the metals according to their transparency.

3. These experimental results and others lead to the conclusion that the transparency of the different substances, assuming equal thickness, is qualified by their density.

---

*Physikalische Institut der Universitat, Würzburg, December, 1895.

[1] By transparency (Durchsechtigkeit) I mean the relation between the brightness of a fluorescent screen when held closely behind a body and its brilliance under the same conditions except that the body no longer intervenes.

[2] For the sake of brevity, I have used the expression "rays" ("Strahlen"), and in order to differentiate from others, the term "*x*-rays."

That density is not the only factor is proved, however, by the following experiments. I investigated the transparency of nearly equal thicknesses of glass, aluminum, calcite and quartz. The densities of these substances are almost equal, yet it was evident that the calcite was noticeably less transparent than the others, the other three being practically the same. I did not observe a particularly strong fluorescence of the calcite itself—particularly strong, that is, in comparison with glass.

4. With increasing thickness all bodies become less penetrable. In order to determine a possible relationship between transparency and thickness, I made photographic pictures in which the plates were covered partially by tinfoil of gradually increasing thickness. A photometric measurement will be made when I get a suitable photometer.

5. Plates of platinum, lead, zinc and aluminum were rolled out to such thicknesses that they seemed to be about equally transparent. The following table contains the thickness in millimeters, the ratio of thickness to that of platinum, and the density.

	Thickness, Mm.	Relative Thickness	Density
Platinum	0.018	1	21.5
Lead	0.05	3	11.3
Zinc	0.10	6	7.1
Aluminum	3.5	200	2.6

From these values it is to be gathered that metals are by no means of similar transparency when the products of their thickness and density are equal. The transparency increases in much stronger proportion as the product diminishes.

6. The fluorescence of barium platinocyanide is not the only notable effect of the *x*-rays. Of next importance is the fact that other bodies fluoresce; for example, certain well-known combinations of calcium and phosphorus, uranium glass, ordinary glass, calcite, rock salt, etc.

Of special significance, in many respects, is the fact that photographic plates have proved sensitive to the *x*-rays. Many phenomena can thus be registered, whereby mistakes are more easily avoided. I have checked every important observation which I saw on the screen by photographs wherever possible.

The ability of the rays to penetrate, almost unhindered, thin sheets of wood, paper and tinfoil is very useful, for the pictures can be made in a lighted room with plates enclosed in a cassette or wrapped in paper. On the other hand, an undeveloped plate protected only by paper or pasteboard cannot be left very long in the neighborhood of the tube.

It seems to be still uncertain whether the chemical effect on the silver salt of the plate comes directly from the *x*-rays. It is possible that this effect is produced by the fluorescent light which arises in the glass, as stated above, or perhaps in the gelatin layer. However, films can be used as well as glass plates.

I have not yet tried to determine whether *x*-rays can produce heat, but this can readily be assumed when the readiness of the rays to be converted is demonstrated through the phenomenon of fluorescence, and when it is certain that all rays falling on bodies leave them as before.

The retina of the eye is not sensitive to the rays. The eye sees nothing when brought close to the tube, although in the light of experiments made so far, the media of the eye must be sufficiently transparent.

7. After determining the transparency of different bodies of relative thickness, I hastened to investigate the behavior of the rays in passing through a prism—whether they are refracted or not. Experiments with water and carbondisulphide in mica prisms of 30-degree angles have shown no refraction, either on the screen or on a plate. For comparison, the refraction of light rays was observed under the same conditions; the refracted beams fell on the plate about 10 mm. and 20 mm. respectively from the position of the direct beam. With a hard rubber and an aluminum prism I have secured pictures in which one could perhaps recognize a deviation. The fact is very uncertain, however, and the deviation, even if present, is so small that the index of refraction of the rays for these substances can at most be 1.05. In this case also I could observe no deviation with the screen.

On account of the slight transparency and the consequent low intensity of the rays that got through, experiments with thicker metals have so far given no certain results.

Owing to the importance of the question as to whether *x*-rays can be refracted or not in passing from one medium to another, it is fortunate, under the circumstances, that prisms are not the only mode of investigation. Because of refraction or reflection, finely powdered bodies in sufficiently thick layers let very little light through. If, then, powder is of the same transparency for *x*-rays as the coherent substances (assuming equal masses), it is proved that neither refraction nor regular reflection is present in sufficient degree to be observed. The experiment was carried out with finely pulverized rock salt, with fine silver powder obtained through electrolysis, and with the zinc dust used so much in chemical experiments. In each case no difference in transparency between the powder and the coherent substance was shown, either by observation or by a photographic plate.

After the foregoing, it is apparent that *x*-rays cannot be concentrated by means of lenses. A large hard rubber lens and a glass lens proved to have no effect. The shadow picture of a round stick is darker in the middle than at the rim; that of a tube, filled with some substance which is more transparent than the material of the tube, is lighter in the middle than at the rim.

8. The question of the reflection of the *x*-rays is to be regarded as settled, since in the experiment of the foregoing paragraph no regular reflection could be noted in any of the substances investigated. Other experiments lead to the same conclusion.

One observation seems to prove the opposite at first glance. I exposed a plate protected by black paper to the *x*-rays with the glass side toward the tube. The sensitive side was covered with polished sheets, with the exception of one portion, of platinum, lead, zinc, and aluminum, arranged in the form of a star. It can be seen distinctly on the developed plate that the darkening under the platinum, the lead, and particularly under the zinc, is stronger than in the other areas. The aluminum had practically no effect. It consequently appears that these three metals reflect the rays. Other causes, however, might account for the darkening; and in a second experiment, in order to be doubly certain, I laid a piece of thin sheet aluminum, which was opaque to ultraviolet rays but transparent for *x*-rays, between the gelatin layer and the metal sheets. Since essentially the same result was again obtained, a reflection of the *x*-rays from these metals is established.

If this observation is considered with the observation that powders are as transparent as the solid bodies; further, that bodies with rough surfaces behave exactly the same as polished bodies (as in the last experiment) in relation to the passage of the rays, the conclusion is reached that there is not a regular reflection, but that the bodies stand in the same relation to the rays that opaque media do to light.

Since I could not prove a refraction in passage from one medium to another, it seems that the *x*-rays move with the same speed in all bodies, and thus in a medium which is present everywhere and in which the molecules are imbedded. The latter furnish an obstacle to the progress of the *x*-rays, and, generally speaking, in proportion to the thickness of the opposing body.

9. It would also seem possible that the arrangement of the molecules in the bodies might have an influence on the penetration of the rays; for example, that a piece of calcite would differ in transparency according to whether the rays went through perpendicular to the axis or parallel to it, the thickness being the same both ways. Experiments with calcite and quartz have, however, given negative results.

10. As is well known, Lenard, in his beautiful experiments on the Hittorf cathode rays passing through a thin sheet of aluminum, came to the conclusion that these rays are agitations in the ether, and that they scatter diffusely in all bodies. We could say the same of our rays.

In his last work, Lenard has determined the absorption power of different substances for the cathode rays, and among others, that for air at atmospheric pressure, his figures being 4.10, 3.40 and 3.10 per cm., depending upon the degree of exhaustion of the gas in the tube. In order to estimate the potential on the tube from the spark-gap, I have used tubes moderately exhausted, for the most part, and have seldom worked with very high or very low vacua. By means of the L. Weber photometer (I did not have a better one) I succeeded in comparing the intensity of the fluorescent light from my screen in air at two distances from the tube—about 100 mm. and 200 mm.—and I found in three experiments, in which fairly similar results were obtained, that the intensity varied inversely as the square of the distance of the screen from the tube. Therefore, the air absorbs much less of the *x*-rays passing through it than of the cathode rays. This conclusion agrees with the observation mentioned above, that the fluorescence can be seen even at a distance of 2 meters from the tube.

In general, other bodies have this same property: that is, they are much more transparent to the *x*-rays than to the cathode rays.

11. A further very noteworthy difference between the behavior of the cathode rays and that of the *x*-rays lies in the fact that after much trouble, I have not succeeded in bending the *x*-rays by means of the magnet, even with very strong magnetic fields.

Up to date, this deflection has been one of the characteristics of the cathode rays. Hertz and Lenard did observe that there were different kinds of rays which were differentiated by "their ability to produce phosphorescence, their absorption, and their deflection by a magnet," but a noticeable deflection was nevertheless observed in all cases tried by them, and I believe this characteristic cannot be overlooked without very good reason.

12. After several experiments undertaken for the special purpose, it is established that the place on the wall of the tube which fluoresces most strongly is to be regarded as the principal source of the *x*-rays, which go out in all directions. The *x*-rays arise at the spot where, according to the reports of various investigators, the cathode rays strike the glass wall. If the cathode rays are deflected within the tube by magnet, it is seen that the source of the *x*-rays shifts so that it is still at the end of the cathode stream.

On this ground also, the *x*-rays, which are non-deviable, cannot be considered as simply unchanged cathode rays which have penetrated the glass wall and have been scattered in all directions. The greater thickness of the glass wall of the tube cannot be considered as responsible for such great variations in deviation.

I come, therefore, to the conclusion that *x*-rays are not identical with cathode rays, but that they are produced by the cathode rays in the glass wall of the tube.

13. This production takes place not only in glass, but in aluminum as well, as I could observe in a tube closed off with an aluminum sheet 2 mm. thick. Other substances will be investigated later.

14. I justify giving the name "ray" to the agent emitted from the wall of the tube partly by the complete regularity of the shadow pictures which appear when more or less transparent bodies are brought between the apparatus and the fluorescent screen (or the photographic plate).

I have observed and also photographed many interesting shadow pictures, the making of which, among other things, offers a wholly unique charm. I have, for example, photographs of the shadows of the profile of a door, which divided the room so that the tube was on one side of the door and the plate on the other; of the bones of the hand; of the shadow of wire wound on a wooden spool; of a set of weights in a small box; of a magnetic needle entirely surrounded by metal; of a piece of metal, the heterogeneous character of which can be seen, etc.

A picture, made with the pin-hole camera, of the tube enclosed in black paper is a further proof of the rectilinear propagation of the *x*-rays. The picture is weak, but nevertheless conclusive.

15. I have made a diligent search for interference phenomena of the rays, but unfortunately, perhaps only because of the slight intensity of the rays, without success.

16. Experiments to determine whether an electrostatic field can in any way influence the *x*-rays have been begun, but are not yet concluded.

17. If we consider the question: "What, then, are *x*-rays—which cannot be cathode rays?" we shall probably be led by the vivid fluorescence and the chemical effects to consider ultraviolet light in the first moment; but here we encounter serious difficulties. If the *x*-ray is really ultraviolet light, such a light must possess the following properties:

(*a*) That in passage from air to water, carbon disulphide, aluminum, rock salt, glass, zinc, etc., it suffers no appreciable refraction.

(*b*) That it cannot be regularly reflected by any of the substances mentioned.

(*c*) That it cannot be polarized in any of the ordinary ways.

(*d*) That its absorption cannot be influenced by any other property of substances so much as by their density.

That means that one must assume that these ultraviolet rays behave entirely differently from the infra-, visible and ordinary ultraviolet rays.

I could not bring myself to accept this conclusion, and sought other explanations.

There seems to be a kind of relationship between the new rays and light rays; at least the picture shadows, the fluorescence and the chemical effects, which are present with both kinds of rays, point to such a relation. We have known for a long time that besides the transverse light vibrations, longitudinal vibrations can also be present in ether, and, according to the view of various physicists, must be present. However, their existence is not yet really proved, and their properties not yet investigated.

May not the new rays be longitudinal vibrations in ether?

I must confess that I have come more and more to believe in this explanation in the course of the experiments, though I admit that the suggested explanation needs firmer foundation.

SECOND PAPER*

Because my work must be interrupted for several weeks, I wish to publish some new results in the following paragraphs.

18. At the time of my first publication, I knew that *x*-rays could discharge electrified bodies, and I thought that it was the *x*-rays and not the cathode rays coming unchanged through the aluminum window which had had the effect described by Lenard on distant electrified bodies. I have waited to publish my experiments, however, until I was in a position to state results to which no objection could be raised.

Such results can only be obtained if the observations be made in a room which is completely protected, not only from the vacuum tube, the conducting wires, the induction coil and all electrostatic influence, but also from the air which comes from the neighborhood of the discharging apparatus.

For this purpose, I built a cabinet of zinc sheets soldered together, which was large enough to hold me and the necessary apparatus, and which was air-tight except for a zinc door, which could be hermetically closed. A great part of the wall opposite the door was covered with lead. At a convenient place, a 4-cm. hole was cut away in both zinc wall and lead covering, and the opening again made air-tight by means of a thin aluminum sheet. The *x*-rays could come into the observation cabinet through this window.

I now made the following observations:

(*a*) Bodies in the air, positively or negatively charged with electricity, are discharged when they come in the path of *x*-rays; and the more intense the rays, the quicker the discharge. The intensity of the rays was judged by their effect on a fluorescent screen or on a photographic plate.

In general, it is immaterial whether the electrified bodies are conductors or insulators. So far, I have found no specific difference in the behavior of the different bodies as to the speed of the discharge, nor in the behavior of positive or negative electricity. Still, it is not impossible that small differences do exist.

(*b*) If a charged conductor is surrounded by a good insulator—paraffin, for example—instead of by air, the exposure to the rays has the same effect as if the insulating cover were stroked with a flame connected to earth.

---

*Sitzungsb. d. phys.-med. Gesellsch. zu Wurzb., 1895.

(*c*) If this insulating cover is surrounded by a closely fitting conductor connected to earth, which is also transparent to *x*-rays, like the insulator, then the exposure has no effect, that I could detect with the means at my disposal, on the inner charged conductor.

(*d*) The observations under *a*, *b* and *c* lead to the conclusion that air exposed to *x*-rays has the power to discharge electrified bodies with which it comes in contact.

(*e*) If this is really the case, and if, in addition, the air holds this power for some time after exposure to the rays, it should be possible to discharge electrified bodies, which of themselves have not met the rays, by bringing to them air which has been rayed.

In various ways one can become convinced that this is indeed the case. I will give one example, though not the simplest:

I used a brass tube 3 cm. wide and 45 cm. long. A few centimeters from one end, the tube wall was cut away and replaced by a thin piece of aluminum. At the other end, sealed off from the air, an insulated brass ball fastened to a metal rod was brought into the tube. Between the ball and the closed end of the tube an auxiliary tube was soldered in, which could be connected with a suction apparatus. When the suction was on, the brass ball was surrounded by air which, in going through the tube, had to flow past the aluminum window. The distance from this window to the ball was over 20 cm.

I placed this tube in the cabinet in such a way that the beam of *x*-rays coming through the aluminum window was at right angles to the axis of the tube, and the insulated ball thus lay outside the path of these rays, in shadow. The tube and zinc cabinet were connected together electrically, and the ball was connected with a Hankel electroscope.

It now developed that neither a positive nor a negative charge imparted to the ball was influenced by the *x*-rays so long as the air in the tube remained undisturbed, but the charge diminished appreciably when the air exposed to the rays was brought to the ball through suction. If the ball was maintained at a constant potential by means of accumulators, and the rayed air then drawn through the tube, an electric current flowed as if the ball were connected with the wall of the tube by a poor conductor.

(*f*) The question now arises: "In what way does the air again lose this property given it by the *x*-rays?" Whether it could lose it without coming in contact with any other body—that is to say, of itself—is not clear. It is certain, on the other hand, that a brief contact with a body of great surface, which does not need to be charged, renders the air ineffective. For example, if a thick enough plug of wadding is pushed into the tube so far that the rayed air must pass through the wadding before reaching the ball, the charge on the ball remains unchanged with suction.

If the plug is in front of the aluminum window, the same result is obtained as without the wadding: a proof that dust particles are not the cause of the discharge observed.

Wire grating works in the same way, though the wire must be very thin and several layers must be laid one on another in order to make the air, passing through, ineffective. If this wire is not connected to earth, as it was before, but connected with a source of electricity of constant potential, I have always observed what I had anticipated; however, this experiment is not yet concluded.

(*g*) If the electrified bodies are in dry hydrogen instead of air, they are still discharged by *x*-rays. The discharge in hydrogen seemed to me to take somewhat longer, although this is not certain on account of the difficulty of maintaining constant intensity of *x*-rays in consecutive experiments.

The method of filling the apparatus with hydrogen had to be such as to eliminate the possibility that compressed air remaining adherent to the surface of the bodies should play an essential part in the discharge.

(*h*) In high vacua, the discharge of an object directly in the path of the rays takes place much more slowly—in one case, for example, about 70 times more slowly—than in the same vessels filled with air or hydrogen at atmospheric pressure.

(*i*) Experiments on the behavior of a mixture of chlorine and hydrogen under the influence of the rays are in process.

(*j*) In conclusion, I want to mention that the results of experiments on the discharging effect of *x*-rays, in which the influence of the surrounding gases was not taken into account, are to be accepted with caution.

19. It is advantageous in many cases to insert a Tesla apparatus (condenser and transformer) between the *x*-ray producing apparatus and the Ruhmkorff coil. This arrangement has the following features: First, the tube is less easily strained and does not get so hot; second, the vacuum endures better, at least with apparatus made by myself; third, many tubes deliver more intense *x*-rays. With tubes of too high or too low vacuum, the Tesla transformer gave good service in getting the tubes to function well with the Ruhmkorff alone.

The important question now arises (and I take the liberty of bringing it up without being able to advance anything toward the answer) whether *x*-rays can be produced by a continuous current from a source of constant potential, or whether, on the other hand, fluctuations of this potential are not necessary to their production.

20. In Section 13 of my first paper, it is stated that the *x*-rays can be produced not only in glass, but also in aluminum. In continuing the experiment in this direction, no solid body has been found which could not produce *x*-rays under the influence of the cathode rays. I know of no reason why liquid and gaseous bodies should not do this also.

However, quantitative differences in the behavior of the various bodies have appeared. For example, if the cathode rays are allowed to fall on a plate, half of which consists of a sheet of platinum 0.3 mm. thick and the other half of a sheet of aluminum 1 mm. thick, it can be seen on a photograph of this double plate made with a pin-hole camera that the platinum sheet sent out many more *x*-rays on the side struck by the cathode rays (the front side) than the aluminum sheet sent out on the same side. However, on the back side almost none are sent out from the platinum, but a relatively large number from the aluminum. The latter group of rays are produced in the front layers of the aluminum and pass through the plate.

One can easily devise an explanation for this observation, but it is best first to investigate still further the properties of the *x*-rays.

It is evident, however, that the facts discovered have a practical significance. According to my experiments so far, platinum serves best in the production of *x*-rays of the greatest possible intensity. I have used for several weeks, with success, a tube in which a concave mirror of aluminum functions as cathode, and a platinum piece placed at an angle of 45 degrees to the axis of the mirror at the center of curvature, as anode.

21. The *x*-rays arise from the anode of this tube. As I must draw conclusions from experiments made with variously constructed apparatus, it is immaterial, as concerns the intensity of the *x*-rays, whether they are produced at the anode or not.

Apparatus was built especially for experiments with the alternating current of the Tesla coil, in which both electrodes were concave mirrors of aluminum, whose axes formed a right angle. A platinum plate to receive the cathode rays was placed at the centers of curvature. Later, I will comment on the usefulness of this tube.

32é

WILHELM KONRAD ROENTGEN

[1845-1923]

Frontispiece, April, 1923
The American Journal of Roentgenolo
& Radium Therapy

THE AMERICAN JOURNAL OF ROENTGENOLOGY
AND RADIUM THERAPY
Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

THE PASSING OF ROENTGEN

THE death of Roentgen, in bringing sorrow to thousands of workers who are professionally christened with his name, shows how truly a great man of science belongs, not to any country, but to humanity at large. Never more clearly has the universality of genius risen above all the barriers of language, commercial interests and political boundaries. Roentgenologists in every quarter of the globe and under every flag recognized Wilhelm Konrad Roentgen as the true seer and founder of their science and are proud to do him reverence in this hour of final reckoning.

It is now over twenty-seven years since a little-known professor of physics in Wurzburg, working alone in his laboratory with a Crookes tube, noticed the fluorescence of a distant card coated with platino-barium-cyanide, and developed the prophetic image of a key upon a photographic plate. Several versions of this astounding discovery have been printed emphasizing its accidental features. It was not an accident. The fact that Roentgen had set up an experimental apparatus with which to study the discharge effects of high-tension electricity through vacuum tubes clearly entitles him, notwithstanding his modesty, to all the results of his observations of these phenomena. We can better appreciate Roentgen's achievement when we recall the many distinguished men who labored diligently in this same field. Sir William Crookes, seventeen years before, had unquestionably produced *x*-rays and had fogged photographic plates; but it remains one of the tragedies of experimental science that he did not recognize his find, although he perceived and recorded the minutiae of the phenomena of the excited vacuum tube and generalized upon them with a brilliancy and insight rarely, if ever, excelled. Hertz, Lenard and others also produced *x*-rays, and noted photographic as well as other effects; but notwithstanding their training and persistence they failed to see and understand the powerful and obedient genii which they had evoked. It required something more than training, more than equipment, even more than industry. The flash of the fluorescent cardboard had to be answered by a flash of genius—and the rest was merely a matter of detail. The way thus opened and illuminated by Roentgen has been explored and widened by innumerable minds until now we are in possession of a new science, a new art and a vast literature requiring of each of its votaries the single-hearted study and practice of a life-time.

Many a discovery is said to have made an epoch. This one made many. It started an epoch in the study of radioactivity. It created another in physics and chemistry. It brought new conceptions of the nature of electricity, of the electron, of the structure of the atom and of the probable constitution of matter. And most of all, it started a revolutionary epoch, which is still in full sway, in the diagnosis and treatment of disease. The end is hidden even yet from the psychic eye of the human imagination.

Professor Roentgen's first communication, given before the Wurzburg Physio-Medical Society, announcing his discovery, should be re-read today by every thoughtful roentgenologist. It is truly remarkable how wide a field he covered and how little change later investigators have found it necessary to make in these first statements. Like Mendel, he read his modest but comprehensive paper before his local medical society. Unlike Mendel's paper, however, which lay forgotten for thirty-six years in scientific archives, Roentgen's discovery was immediately transmitted throughout the world. Inevitable skepticism was silenced by rapid confirmation from reliable sources on every hand and an admiring public accepted as an article of faith one of the most beneficent miracles ever recorded in the scripture of science.

The forced belief in something so entirely new and so peculiarly opposed to universal experience shook the foundations of common sense. Since then, other discoveries scarcely less revolutionary and even more spectacular have well-nigh swept away this ancient anchorage of the mind. Almost any absurdity with a pretense of electronic-or radioactivity, if couched in scientific terms, now finds eager acceptance. Skepticism in theological matters is in curious contrast to the easy belief in anything covered by the supposed mantle of science. A recent example from the Pacific Coast, among others, has demonstrated that at the present time human credulity regarding pseudo-science has ceased to have any discernible limits. A study of Roentgen's work, and, in general, the popularization of the work of the real masters of science, will help to re-establish a few beacon-lights for the future course of public opinion.

But, in any event, we have faith that true scientific research will never want for workers in any field. Now, especially, roentgenologists must feel the call. The final conquest of the unseen world which lies beyond the boundaries of the visible spectrum is committed to our hands in sentiment as well as in fact by the passing of this great master. His work shows that no phenomenon is too small for careful observation. His discovery arose out of a long series of investigations which appeared hopelessly remote from human usefulness. From the seed of pure science has ever grown the most fruitful harvest for humanity. Roentgen's life as a teacher and experimenter was devoted to non-utilitarian ends, and will ever inspire hope in the humble unknown worker that out of his apparently unproductive research may come the splendid vision of a new truth.

Roentgen's career was consistently that of a teacher and investigator. He served as a professor of physics at Hohenheim, Strassburg, Giessen and Wurtzburg. From 1899 he held the chair of experimental physics at Munich and was given a pension by the imperial government. Scientific bodies in different parts of the world vied with each other to pay him honor. He accepted the Rumford Medal of the Royal Society of London, the Barnard Medal of Columbia University, and, in 1901, the Nobel Prize in Physics. He suffered the common ruin of his countrymen during the great war, and died in poverty in the house of a friend.

CINEMA-CARDIO-ROENTGENOGRAMS

On Friday evening, February 9, 1923, Doctor Franz M. Groedel, of the University of Frankfort, Germany, demonstrated his cinema-cardio-roentgenograms to the Eastern Medical Society of the City of New York.

Doctor Groedel first described his apparatus and showed moving pictures of it. He uses a long film perforated at the edges and otherwise similar to the ordinary cinema film, except that it is wider. The film is enclosed in a holder, and is entirely protected from ordinary light and from the *x*-rays except for an area a little larger than that of the heart. The film is pulled between two intensifying screens by a mechanism similar to that used on the motion-picture camera. The technique is as usual for ordinary radiographic work. The film changes between exposures.

An electrocardiogram is made simultaneously with the roentgenogram and reproduced on the finished film.

Though the work is interesting in the same way that all new things in medical fields are interesting, and to a layman might seem most spectacular, it seems to the reporter to be of little actual value in its present form, and also that much more information could be gained in a few minutes of fluoroscopy.

The result as presented was far from ideal. Evidently much time elapsed between exposures, and on the screen the heart appeared to jump about like the often-referred-to fish out of water. This is of course not surprising when we consider that the average normal heart cycle is 0.8 seconds, and that during approximately half of that time the whole heart is in diastole; so that, to show the changes at all smoothly, at least ten exposures would have to be made every second. The difficulties to be encountered can be easily appreciated by all of us.

Eugene V. Powell.

FOURTH ANNUAL MEETING OF THE CENTRAL SECTION

The Fourth Annual Meeting of the Central Section of the American Roentgen Ray Society was held at the Seelbach Hotel, Louisville, Ky., on Saturday, February 24, 1923.

The program was as previously published, and in addition Dr. Samuels read a paper on "Roentgen Interpretation of Ileocolonic Stasis."

There were 77 registrations, with an attendance of more than 100. Everyone seemed highly pleased with the program.

The following officers were elected for the ensuing year:

President: D. Y. Keith, Louisville, Ky.

First Vice-President: W. O. Upson, Battle Creek, Mich.

Second Vice-President: Charles Goosman, Cincinnati, O.

Secretary: R. C. Beeler, Indianapolis, Ind.

The next meeting is to be held in Indianapolis, Ind., on Feb. 23, 1924.

CORRESPONDENCE

To The Editor:

In my article on the Function of the Muscles of the Stomach, which appeared in the Dec., 1922, number of your Journal on pages 792 and 793, there are published four photographs of dissections of the muscles of the stomach which are inadequately acknowledged. The slides are labelled with the initials "G. J.," and there is a reference to them in the text, but I wish it to be quite clear that the photographs are from dissections made by Geoffrey Jefferson, F.R.C.S., of Salford Royal Hospital, Manchester, Eng., who made these dissections some years ago, by following out the picric acid technique of Forssell.

I would be grateful if you would make this acknowledgment for me in your Journal.

I am

Yours faithfully,

A. E. Barclay.

March 20, 1923.

EXAMINATIONS OF THE NATIONAL BOARD

The following dates are given by the National Board of Medical Examiners for their approaching examinations: Part I, June 25, 26, 27, 1923. Part II, June 28, 29, 1923.

Part I, Sept. 24, 25, 26, 1923. Part II, Sept. 27, 28, 1923.

All applications for these examinations must be made on or before May 15th.

Further information may be obtained from the Secretary, Dr. J. S. Rodman, 1310 Medical Arts Building, Philadelphia, Pa.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page v of this number of the Journal. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal (*69 East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Pilger, W. Deep *X*-Ray Therapy: The Technique of the Erlangen Clinic. *Lancet*, Jan. 20, civ, 115.

The Erlangen Clinic still adheres to the dosage fixed for various conditions as previously published. The unit skin dose being standardized as 100, the proper dosage can be ascertained for various pathological conditions. The following is the dosage fixed: Cancer, 90 to 110 per cent; sarcoma, 70 to 80 per cent; ovaries (sterilization), 35 per cent; and so on. The technique for uterine cancer is essentially the same as has previously been referred to in this journal (Sept., 1922, p. 530). Cancer of the breast is radiated by two distant exposures, one in front and the other behind. The distance and field size depend on the situation and size of the tumor. The irradiation doses to the tumor and the axilla may be given at the same time or separately; the supraclavicular glands must also be radiated. As the cancer dose is always calculated at the lowest limit, a second radiation is generally given in these cases.

General harm and nervous disorder may be caused to the body by large *x*-ray doses, the effect being chiefly manifested in the blood circulation. A sudden fall of lymphocytes and relative leucocytosis occurs; whenever possible, therefore, large cones of irradiation are avoided and concentrated doses given. The use of a compressor is recommended when the cross-fire method is adopted. Compression produces anemia of the skin, which is thus rendered slightly less susceptible to *x*-rays. Secondly, the movable bowels are pressed aside (in the case of abdomen), so that they do not interfere so much with the cone of radiation. For good results to be obtained, the patient must be in a fit state for treatment, just as in any major operation; the condition of the blood is of paramount importance and must be ascertained.

The preparation for treatment is as usual for a surgical operation. Nothing is done to the areas to be treated. The patient is given a light cup of tea in the early morning and nothing else. There should be no barium residue in the bowels. No medicaments containing iron should be given. Scopolamine or morphine should be injected on the table.

As after-treatment the author recommends the following: (1) Avoid all irritation to the radiated part of the body, from clothes, rubbing, scratching, soap, irritating ointments, etc.; (2) therefore apply for some weeks, every day, unsalted lard or *unguentum leniens molle;* (3) give rectal injections of pure olive oil, in gynecological cases, to protect mucous membranes of rectum and colon; (4) in cancer of the bowels anastomosis before radiation is recommended, as it prevents the radiated part from being constantly irritated by the contents of the stomach; (5) never make any incisions on the radiated areas if there happens to be swelling or induration after the treatment of *x*-rays; (6) vomiting, headache, and thirst, which often occur after treatment, pass off as in the case of surgical operations; (7) a subcutaneous injection of physiological saline is recommended after radiation, each case being treated on its merits; (8) intravenous injections of albusol (a preparation of pure proteins) are given in cases of anemia and when the patient is of a nervous type; (9) iron, arsenic, and other general tonics are useful; (10) calcium lactate has also been found of use.

Having regard to the above principles, good results can be obtained in all kinds of malignant growths, irrespective of the question whether operable cancers should be treated only by *x*-rays or should be operated on and subsequently treated by *x*-rays. There is no doubt that the use of this new weapon marks a great advance in the fight against cancer. Sufficient time has not yet elapsed to show whether it will completely replace surgery in the fight against malignant growths, but the results obtained are, up to now, at least as good as those of surgery. In this connection we must take into consideration the fact that in compiling statistics the surgeon includes only operable cases and excludes inoperable ones, while *x*-ray therapy statistics include a large amount of inoperable cases, in which *x*-ray is the only possible treatment.

Other types of cases suitable for *x*-ray treatment are sarcomata, lymphosarcomata, lymphogranulomata (Hodgkin), myomata, and climacteric diseases. The results obtained in the latter are so excellent and the treatment is so agreeable and safe that there is no possibility of discussion about it. In Germany, operation is no longer performed on a myoma unless there are necrotic and infectious parts in it, or unless the tumor be so large that it threatens the function of the bladder or rectum.

During the past few years Professor Wintz has introduced into the Gynecological Hospital in Erlangen a remarkable means of treating chronic inflammatory conditions of the adnexa. These conditions are very tedious, for the Fallopian tubes and the ovaries resist all kinds of treatment; the growths are subject to recurrence by reason of the monthly congestions that take place in the female genital organs.

By suppression of the function of the ovaries for two or three years by a suitable dose (a little smaller than the full castration dose) of *x*-rays applied to the ovaries, excellent results in these diseases have been obtained. Other diseases which can be successfully treated by *x*-rays are tuberculous glands, and tuberculosis of the peritoneum and joints, especially small joints.

It would take too long to enumerate all the skin diseases that can be successfully treated by *x*-rays, but in general it has been found that the use of hard penetrating rays gives better results than the use of soft rays. Excellent results have been obtained in advanced cases of actinomycosis. Other cases suitable for treatment are glands of internal secretion, either in order to suppress hyperfunction or to stimulate deficient function. The exact dosage in these cases has not yet been completely worked out. In the treatment of Basedow's disease, two-thirds of a unit skin dose to the thyroids and the thymus is the best.

In summarizing the diseases treated by *x*-rays the author names the following: (1) All malignant growths of cancerous type; (2) sarcomata, lymphosarcomata, lymphogranulomata; (3) myomata and diseases of the adnexa; (4) tubercular glands, peritoneum, and joints, especially small joints; (5) actinomycosis; (6) disordered functions of glands of internal secretion.

The number of treatments ranges from one to four.

Roussy, G. Laborde, S., Leroux, R. and Peyre, Ed. Concerning Regular and General Reaction of the Organism Following Radiation Treatment of Cancer of the Cervix Uteri. *Proceedings of the French Society for the Study of Cancer*, June 19, 1922.

Surprised by the analogy of the blood findings furnished by two cases of very similar clinical evolution, the authors undertook the systematic examination of the blood of cancerous patients submitted to radium and roentgen treatment to see if it was possible to find a biological test which was susceptible of comparison with the clinical evolution.

The observations were completed by the study of tissue removed at biopsy, repeated every eight days, with the purpose of following the local effects of treatment on a part and also for the purpose of comparing the methods of local reaction of the organism with regard to cancer with the information of a general order furnished by the examinations of the blood. The following facts have been shown:

1. The study by serial biopsy of a tumor in the course of radiotherapeutic treatment of cancer, and that of the blood reactions simultaneously carried out, show that they are parallel, and give very different results according to the progress which is made toward cure, or, on the other hand, toward progressive extension of the disease and death.

2. The local study of the histological reactions of the tumor, and especially the study of the connective and vascular tissue, seem to furnish certain elements of prognosis for the favorable or unfavorable development of the disease. For instance, an altered stroma with fibrinoid lesions and necrotic areas before any treatment is started would suggest the necessity for extreme care in treatment for fear of bringing about serious accidents. On the other hand, an intact stroma should presage a rapid cicatrization.

3. The examination of the blood seems to furnish a means of foreseeing and of following the general reactions of the organism in the course of radiation therapy. One should note not only the phenomena of radiosensibility and the local reaction of the rays on the tumor, but also the manner in which the organism reacts, in order to draw deductions of prognostic value and indications as to the method of treatment to be continued. When before any treatment has been given the blood picture is unfavorable, the employment of *x*-rays or radium for treatment in the manner ordinarily used has a tendency to accentuate the general symptoms. In such cases one should carefully plan his work to modify the ordinary technique. If, on the other hand, before any treatment has been given, the blood picture is favorable, irradiation can bring about temporary severe reaction, but this is usually transient and the prognosis remains good.

Graves, Roger Colgate. Shadowless Renal Calculi. *Ann. Surg.*, Apr. 1922, lxxv, 487.

It is common knowledge that a small percentage of renal calculi fail to cast shadows in an *x*-ray plate. Holmes and Ruggles state that with satisfactory technique "probably 80 to 90 per cent of kidney and ureteral stones will show." Those occasional calculi which present no greater density than the body soft parts are chiefly of uric acid or urate composition.

Two interesting cases of cystin calculi are reported by the author, where, following the injection of an opaque solution into the ureter and renal pelvis, invisible stones were shown by negativity. The author believes that calculi of pure cystin should be classified in general with those concretions which possess no greater density than the body soft parts.

Bell, J. Warren. Pelvioradiography After Fabre's Method. *Am. J. Surg. & Gynec.*, Dec., 1921, ii, 616.

Following the description of a method of pelvimetry by Fabre two years ago, the author has employed this method in a number of cases. The technique is as follows:

The patient is placed in the ventral position, with a large cassette beneath her abdomen which contains the 17 × 22 in. film and an intensifying screen 10 × 14 in. The tube was placed at a point toward the patient's feet 50 cm. from the symphysis, and 50 cm. from the table. The tube is so tilted that the direct rays enter the outlet of the pelvis and leave through the inlet. The frame is made of wood, and is adjustable to the size of the patient. The frame is applied as nearly as possible to the plane of the inlet. This plane is determined by the three points; the top of the symphysis, and the two dimples of the posterior inferior spines of the ileum. The wooden frame contains a lead layer with notched edges, the notches being 1 cm. apart. The film must be large enough to show the shadow of the entire frame.

By joining opposite notches the accurate measurements of the picture of the pelvis can be quickly obtained. From this film, with the unavoidable distortion, a true outline of the inlet is made upon graph paper with centimeter squares.

Grosh, L. C., and Stifel, J. L. Defects in the Membranous Bones, Diabetes Insipidus and Exophthalmus with Report of a Case. *Arch. Int. Med.*, Jan. 15, 1923, xxxi, 78.

The purpose of this paper is to describe an additional case, seven similar cases having been previously reported.

The patient was a girl seven years old, having healthy parents and no evidence of inheritable disease. Brothers and sisters were normal. Birth was normal and child showed no abnormality for one year. During her second year there was lack of development and underweight. At the age of six she had an infected tooth which was followed by mastoiditis, requiring operation. Seven weeks thereafter a marked thirst developed, tests of intake and output showing a definite diabetes insipidus. At the time of first observation the patient was seven years old. Her weight was 30 lbs. and she was only 3 ft. 8 in. high, showing some evidence of dwarfism. The teeth and gums were in bad condition and there was a bullous eruption in the mouth; also exophthalmus of the left eye. An *x*-ray examination revealed an area of rarification in the right temporal bone about 5 × 10 cm., with loss of lime salts and complete translucency of the bone.

During the next three years the condition of her mouth improved considerably under dietary treatment. Her diabetes insipidus remained troublesome, however, and her exophthalmus continued. *X*-ray examination of the skull revealed an extension of the rarifying process, involving the entire side of the skull. Numerous small areas of similar rarification were present in the other membranous bones and a very large area was found in one ilium. The edges of the calcium free areas were scalloped, not resembling any of the bone changes seen in syphilis, tuberculosis, osteitis fibrosa, Paget's disease, bone cysts, or sarcoma. Certain rarifying types of metastatic carcinoma are the only conditions with which this might be confused.

The author discusses this and 7 previously reported cases at length, but no attempt is made to advance any new theory as to the cause of the condition. Several very instructive illustrations are included.

Pancoast, Henry K. The Roentgenologic Aspect of Chronic Appendicitis. *Arch. Surg.* Jan., 1923, vi, 85.

The value of the roentgen examination in connection with appendicitis is discussed under several heads:

1. Congenital anomalies. The only anomalies which need consideration are transposition of the viscera and failure of complete rotation of the cecum.

2. Visualized appendix. Unfortunately, the appendix is not visualized in every case in which a gastrointestinal study is made. Visualization depends on the patency of the lumen to the opaque medium. It seldom occurs during an opaque enema. Obliteration of the lumen naturally prevents filling, but it is not to be expected that every normal appendix will fill with contents of the cecum at all times. Our dependence on observation of the visualized appendix lumen must be limited to a certain proportion of cases. This study must be mainly fluoroscopic. When plates are made they must be made under fluoroscopic control. The diagnosis of disease is based on many appearances. Adhesions to the cecum, pelvic colon, ileum, or other structures must be determined from fixation detected by palpation. The emptying time of a visualized appendix is important. Poor drainage is shown by appendical stasis. Poor drainage cannot be regarded as evidence of disease except so far as a poorly draining appendix can be regarded as diseased, or potentially so.

More or less discomfort is usually experienced when firm pressure is exerted over the appendix or cecum, but if exquisite tenderness is experienced when the pressure is made directly over the appendix under fluoroscopic control, this finding is of considerable value. Even if the appendix is not visualized, the roentgen ray always reveals its probable relation to the tip of the cecum, and tenderness at this point is always suggestive. It is wise to have clinical data furnished by a pelvic examination before interpreting tenderness over an appendix or low cecum. The finding of a retrocecal appendix is always an important one; but its significance must be determined by the clinician and surgeon. Certainly, if it is long, fixed, and pointing upward in a case with symptoms referable to the right upper quadrant, the value of such an observation may be very great.

Fecal concretions or opaque foreign bodies in the appendix are obviously important.

3. Abnormal appearances in other structures. When the appendix is not visualized, the presence of disease must be indirectly inferred from abnormal appearances in other structures. However, it is quite possible for the appendix to be diseased without any manifestations elsewhere. Most important is the presence of adhesions, especially to the terminal ileum. If this structure is kinked or adherent to the cecum and pelvic inflammatory disease can be ruled out, the origin of such adhesions is probably the appendix. Iliac stasis alone, provided gastric motility is not delayed, suggests disease of the appendix. Continued exquisite tenderness at the tip or lower inner border of the cecum is a sign of considerable importance. Definite pyloric spasm may be an evidence of appendical trouble.

4. The discovery of some conditions other than those of the appendix to account for symptoms. Such other conditions include stone in the ureter, gall-bladder disease, gastric and duodenal ulcer, diverticulitis of the colon, inflammation of Meckel's diverticulum, early malignant disease of the intestine, tuberculosis of the cecum, and disease of the spine. Numerous other conditions, of course, exist, especially in gynecological diseases, which are usually beyond the pale of roentgenology. Adhesions of the diaphragm may point to a previous pneumonia or pleurisy with abdominal manifestations.

5. The discovery of some other condition accompanying appendicitis. The frequent coexistence of a diseased appendix and some other surgical condition of the abdomen is well recognized. If the symptomatology is in the least obscure, or some other condition is suspected elsewhere in addition, a complete roentgen study should be made.

LE WALD, LEON T. The Relation of the Heart, Pericardium and the Heart Valves to the Anterior Chest Wall. *Arch. Surg.* Jan., 1923, vi, 89.]

The author cites the statements of our leading anatomists, finding great variations in the position of the heart and its valves as reported by different anatomists. At the suggestion of Professor Senior, of the Bellevue Hospital Medical College, cadavers were injected through the right carotid artery with equal parts of commercial liquor formaldehyde and water, the injection being begun with the body in the horizontal position and finished with the body in the vertical position. The body, which had been stored in the horizontal position for some months, was frozen and the thorax removed.

The frozen thorax was then cut accurately, by means of a band saw, in the frontal plane so as to open both auricles from behind, without interfering with the contour of the heart. In the intact interior portion of the thorax, the mitral and tricuspid valves were readily accessible. Wires were bent so as to fit accurately the groove corresponding to the attachment of the valves to the heart wall. The wires were placed in position from the auricle, and, in the case of the tricuspid valve, fixed by means of two sutures. The cusps of both auriculoventricular valves were found to be in apposition. The interior of the aorta was reached through the anterior wall of the left auricle. The region of the pulmonary valve was made accessible by removing the remainder of the left lung and cutting the artery longitudinally from the left side. Wires were shaped to fit the aortic and pulmonary orifices and placed so that they were in contact with the deepest part of each of the semilunar valve cusps, which provided excellent guides in placing the wires. After placing the pulmonary ring, the cut edges of the vessel came into position. The accuracy of the position of the wires was verified after roentgenograms had been taken.

Teleoroentgenograms and stereoroentgenograms were made. The apex is in the fifth intercostal space, from 7.5 to 8 cm. (3 to 3¼ in.) from the median line. The base corresponds to an imaginary line (A) drawn from a point 1 cm. (⅖ in.) below the second left chondrosternal articulation, and 3 cm. (1⅕ in.) from the median line to another point the same distance from the median line, 1 cm. above the right chondrosternal articulation. The margo acutus, or lower border, corresponds to a line (B) drawn from the apex through the xiphisternal articulation, to a point on the sixth costal cartilage, 2 cm. to the right of the median line. The right border of the heart may be indicated approximately by an imaginary line (slightly convex to the right), joining the right ends of lines A and B. The left border corresponds to a line (slightly convex to the left) joining the left end of A to the apex.

If a line is drawn from the upper margin of the left third chondrosternal articulation to the right edge of the sternum in the fifth intercostal space, the upper end of the line will lie over the center of the pulmonary orifice, and the lower two-thirds of it (approximately) will overlie the main axis of the tricuspid orifice. The aortic orifice is immediately to the left of the above line, with its center at the left edge of the sternum, opposite the third space. The mitral orifice is very largely behind the third left interspace; its upper end is behind the third cartilage, its lower behind the left margin of the sternum, opposite the fourth cartilage and space.

Of the orifices of the heart, the pulmonary is the nearest to the anterior thoracic wall; the tricuspid is slightly in advance of the aortic, and the mitral deepest of all.

The pericardium follows the outline of the heart closely. The upper end (apex) in this subject extended up behind the sternum, to the lower margin of the first costal cartilage on the right and the upper margin of the second on the left.

The positions occupied by the cardiac orifices may be seen plainly in the illustrations. It may be said, however, that all the rings are seen from the lower (anterior) aspect except the aortic, which is seen from above.

CASSIDY, WM. J. Carcinoma of the Breast, Its Combined Treatment with Surgery, *X*-Ray and Radium. *J. Mich. M. Soc.*, Feb., 1923, xxii, No 65.

After carefully referring to the surgical technique the author explains that it has been his practice when possible thoroughly to *x*-ray cases before operation, and after careful block excision to begin intensive *x*-ray treatments. Latterly this has been supplemented by direct implantation of radium element into the uterus at operation. The author claims that consistent and efficient combination of the three methods referred to, if persistently and carefully used, will obtain eight-year cures in over 80 per cent of patients.

BROOKS, CLARK D., and CLINTON, WM. R. Radium Treatment in Cancer of the Cervix. *J. Mich. M. Soc.*, Feb., 1923, xxii, No. 65.

The author emphasizes pre-operative treatment with the *x*-ray as a means of rendering the inoperable cases operable. He urges that the combination of radium and *x*-ray therapy in cases of uterine cancer has a definite place in the treatment of this disease. First, with clinical cure of some; second, with alleviation of those two very distressing symptoms, namely, foul discharge and bleeding; third, lessening the morbidity.

BEATTIE, ROBERT. Treatment of Sub-Acute and Chronic Otitis Media with the Use of the *X*-Ray. *J. Mich. M. Soc.*, Nov., 1921, xx, 449.

Following an epidemic of influenza in which there developed a great many cases of acute otitis media, the author had an opportunity to test the effect of the *x*-rays on the acute and chronic suppurative processes. To his surprise, several of the cases cleared up entirely within two or three days following *x*-ray examination. At first he thought it merely a coincidence, but later concluded that there was a relation between the *x*-ray application, even for diagnosis, and the cure.

The work was carried out in association with Dr. George Chene.

Treatment: 6½ in. spark-gap; 10 in. skin target distance; 3 ma. current; 3 mm. aluminum filter plus one thickness of sole leather.

The conclusion of the author is that the *x*-ray is of possible value in the treatment of sub-acute and early chronic types of otitis media. In the chronic cases, however, where necrosis of bone has occurred, the value is doubtful. The effects seemed to be procured independent of the type of infective microorganism.

EVANS, WILLIAM A. *X*-Ray Treatment in the Diseases of the Ear, Nose and Throat. *J. Mich. M. Soc.*, Feb., 1923, xxii, No. 65.

The author's interest in this subject was stimulated by the publication of Witherbee's article on the treatment of tonsils. This work was supplemented by a somewhat extensive study of *x*-ray exposure on diphtheria carriers recently published by Dr. Hickey, which demonstrated the efficiency of *x*-ray exposures in the treatment of diphtheria carriers, the percentage of cures being higher than by any other method. Whether the infection was in the ear, the nose, or the throat, there was a higher percentage of sterilization. In addition to the action upon the Kloebs-Loeffler bacillus, it was noted that practically every throat was cleared of the streptococcus-hemolyticus and other virulent organisms.

In the ear, definite clinical improvement occurred in cases associated with a low-grade infection, that is, the sub-acute ear infections of children and the more chronic ones of adults. Good results were also obtained after radiation for the purpose of stimulating granulation in the retarded healing following mastoid operation.

The author offers no conclusions regarding oteosclerosis. Many ear symptoms associated with obstruction of the Eustachian tubes by pharyngeal conditions are, of course, relieved by exposure of the nasopharynx.

Results in the treatment of paranasal sinus disease have not been encouraging.

A case of simple lymphoid hypertrophy, either in the child or in the adult, should be treated by radiation rather than by the surgical removal of the offending tissue. There is a type of lymphoid infection in which satisfactory results will be obtained only by the combination of the ultraviolet ray and the *x*-ray. Actively infected tonsils should be surgically removed. This includes cases showing the usual serious complications of tonsillitis, such as endocarditis, nephritis, acute arthritis, etc. Little or no beneficial results are obtained in treating tonsils of the fibroid type. Postoperative radiation will increase the percentage of surgical cures.

Case, James T. The New Roentgenotherapy in Gynecology. *Texas State J. M.*, Nov., 1922.

After reviewing the development of deep roentgen therapy and defining it, the author discusses the value of the newer method in gynecology. Various German statistics are reviewed and the results criticized. The author feels that the published German figures overstate the results, but even the most bitter critics of the over-enthusiastic admit perhaps 15 per cent of apparent cures in inoperable cases. Several well-known gynecologists have abandoned operative treatment of the uterus in any stage.

The author recommends an interval of from six to twelve weeks between treatments, although in a few cases where the first series of treatments failed to produce a definite reddening of the skin, the urgency of the situation has led him to give a supplementary dose within two weeks. Late-appearing damage to the skin has not been seen in any gynecological case, but in no instance has the author continued the treatment after the third massive application. Radium is also used in association with the *x*-ray in the treatment of gynecological malignancies; but for benign lesions of the pelvis in which radiation is indicated it cannot be stated that the newer high voltage apparatus or the radium is necessary, although certainly a great convenience.

Pendergrass, Eugene P., and Pancoast, Henry K. The Roentgen-Ray Treatment of Erythremia. *Am. J. M. Sc.*, June, 1922, clxii, 797.

The authors discuss the close relationship of the erythrogenetic and leukogenetic functions of the bone-marrow in disease and report a case of erythremia. They conclude that erythremia is a disease of the erythroblastic tissues of the bone-marrow; roentgen rays destroy or inhibit the formation of red cells; roentgen rays should be used in the treatment of erythremia; roentgen rays should be used in the treatment of secondary polycythemia when such cases fail to respond to other treatment, such as drugs, venesection, etc.; roentgen-ray treatment has been efficacious in the case reported and it has proved of value in cases reported by other roentgenologists; roentgen therapy effects a more permanent result than any other therapeutic measure used or recommended up to the present time.

Various authors agree that the spleen is more sensitive than the bone-marrow to roentgen rays. After moderate doses of the rays the leukocytes show an initial rise, followed by a pronounced fall and a subsequent rise to normal. The red cells show an initial fall after moderate doses of roentgen rays. This may last for long periods of time or the cells may rise to normal in the course of a few days. Whatever may be the ultimate success of roentgen therapy in erythremia, *x*-ray treatment is merely an agent recommended in an effort to find something that will give relief to this class of patients.

The treatment of the spleen is given to stimulate the functions of that organ. In the case reported, seven series of roentgen-ray treatments were given over the bones and the spleen, and in addition, at times, cross-fire applications were given over the spleen because of the presence of myelitis. The seven series of treatments were given between December 3, 1917 and April 20, 1920. After the series of treatments the patient's blood count was practically normal and at the time the article was written he was feeling very well. He had no cyanosis or florid color, but the splenic enlargement persisted. In fact, the spleen was larger at the date of reporting than when the patient was first seen.

Dunham, Kennon, and Skavlem, John H. Sinus Disease and Lung Infections. *J. Radiol.*, Feb., 1923, iv, 37.

The first step in the differential diagnosis of lung diseases is to determine whether the lesion is tuberculous or non-tuberculous. In any case of apical catarrh, purulent bronchitis, bronchiectasis or localized areas of pneumonia, infection in the head or throat should be sought. The symptoms of incipient pulmonary tuberculosis are the symptoms of a focal infection. A properly interpreted x-ray chest plate is the most valuable aid in the differential diagnosis of tuberculous lung lesions and acute infections secondary to sinus disease.

Collin, Edward. A Study on the Roentgen Aspect of Tuberculosis of the Joints and its Relation to the Clinical Aspect, especially when under Treatment by Universal Light Baths. *Acta Radiol.*, i, Fasc. 4, pp. 395–405.

1. Even if the roentgen aspect reveals no sign of tuberculous changes, it does not exclude the possibility of the affection being tuberculous.
2. Sometimes the roentgenological changes come only at a moment when the clinical symptoms have considerably improved.
3. The light treatment of surgical tuberculosis can yield extremely fine results, even where serious roentgenological changes are found; for which reason one cannot, on the basis of these alone, give a bad prognosis; because even very large destructions may be repaired.
4. Complete roentgenological healing may occur long after the clinical symptoms have disappeared.
5. Tuberculous osteitis can heal spontaneously, but under light treatment the result is cosmetically and roentgenologically far better, and is attained more quickly.
6. Simultaneously with clinical improvement considerable roentgenological deterioration is seen at times. In reality this is merely the sign of the diseased material being resorbed.
7. Extensive arthritis in hand, ankle, knee and elbow-joint can heal with new formation of articular cartilage and good function.
8. A joint-end seen deformed roentgenologically can occur simultaneously with a completely free function clinically.

Waldenström, H. The Definite Form of the Coxa Plana. *Acta Radiol.*, i, Fasc. 4, pp. 384–394.

The diagnosis coxa plana essentialis can with certainty be made only during the evolutionary stage. The definite form can therefore only be studied in cases that are followed from the beginning of the disease.

To endeavor to explain the definite form of coxa plana I have examined those cases where I have been enabled to follow the development from the beginning until the end of the period of growth. There were 22 hips; 10 of these have attained an age of over twenty years.

The definite form, that I can hereby establish, is shown to be very variable in respect to the degree of the deformity, but the flattening of the caput, collum and acetabulum is common to all.

By roentgenograms, from both frontal and lateral views, one can obtain a plastic picture of the form of the caput and collum in the different cases. It can then be seen how it is mainly the anterosuperior portion of the caput that is enlarged, and that this portion, in the more pronounced cases, lies outside of the articulation. With respect to the degree of the deformity, I have divided the definite coxa plana into three groups:

1. The caput preserves a rounded form. The caput and the collum can be well distinguished from each other and from the trochanter.
2. The upper and frontal part of the enlarged caput lies close to the greater trochanter. This portion of the caput is seen in the lateral projection, greatly enlarged, lying outside of the articulation. The upper part of the collum is not seen.
3. The joint-surface of the caput is uneven and more or less excavated. The upper pole of the caput is edgeformed and usually lower than the summit of the greater trochanter.

Laurell, Hugo. A Contribution to the Roentgenology of Genuine Mixed Tumors of the Trunk. *Acta Radiol.* i., Fasc. 4, pp. 406–417.

The author has collected from the literature a number of roentgenologically examined, positive, genuine, mixed tumors, localized to the pelvis, mediastinum or lungs; besides cases suspected as such. Of these only two could be roentgenologically diagnosed with certainty before the operation: viz., those of *Josephson-Söderlund* (1915) and *Edeiken* (1922). In both these cases a pelvic dermoid was present and the finding of dental elements in the wall of the dermoid cyst served to establish the diagnosis. In the other cases the diagnosis was not made until after the operation or remained uncertain. while neither at operation nor section could a positive diagnosis be made.

The author shows some roentgenograms from a resected pelvic dermoid (not roentgen-examined before the operation) which contained a well-developed tooth with a distinct root-canal, also a retroperitoneal teratoma in the superior portion of the abdominal cavity, which he had roentgen-diagnosed in 1919. This latter case is described in detail. The finding of an irregular mass of bone, a cyst fully the size of an orange, and a tooth with visible root-canal enabled him to make his diagnoses.

In agreement with other authors the writer emphasizes the importance of bearing these mixed tumors in mind at the roentgen examination of the inner organs of the trunk, which, thanks to the occurrence of bone and tooth elements, can be diagnosed in a fairly big percentage. Well-developed teeth are of particularly great diagnostic value. If the teeth are deformed, however, or for technical reasons or others do not appear distinctly on the plate, then they can occasion misinterpretation. For instance, when shown to be in the urinary tract, they can lead to diagnoses of concretions in the ureter.

The dental elements can lie quite free in these tumors or be imbedded in a distinct matrix of bone; they can be found isolated or multiple, deformed or normal. They can appear as permanent or as milk-teeth and at various stages of development. It is important to remember that tooth and bone elements can be found without the coincidental presence of a palpable tumor.

If the mixed tumors contain no bone and tooth elements, then they cannot be diagnosed with certainty. However, it is of a certain diagnostic value if we can prove the shape of the tumor, which is possible with some of these growths. It is most easily accomplished when they are localized to the thorax and are surrounded with transparent pulmonary parenchyma, but also possible when found in the abdominal cavity and pelvis. These genuine mixed tumors (dermoid cysts) are mostly of a more or less rounded shape, but other forms of them can have rounded outlines too, at least in part.

Nordentoft, S. On the Roentgen Treatment of Brain Tumors. *Acta Radiol.*, i, Fasc. 4, pp. 418–421.

A report of 19 cases of clinically diagnosed tumor of the brain, treated by roentgen irradiation. Probably some of them have been cyst meningitis serosa etc., not responding to irradiation. Nine of them seem to be cured (some of them with remaining defects as, for instance, hemianopsia) and are surviving, one of them two and a half years, the others from three and a half to six and a half years after treatment. Through the good effects of irradiation the diagnosis of brain tumor is confirmed.

Edling, Lars. The Results of our Treatment of Tuberculous Lymphadenitis by Roentgen Rays at Lund from 1908 to 1918. *Acta Radiol.*, i, Fasc. 4, pp. 455–469.

After having quoted the most important dates in the history of the radiotherapy of lymphadenitis, the author describes the development of the technique of this treatment at the Roentgenological Institute in Lund. Since 1913 to 1914 this technique is characterized by the method of deep irradiation with aluminum filters of 3–4 mm., of secondary filters in gauze, a focus distance of 18–20 cm. and doses varying from 1½ to 5 H (larger doses only by exception); for children, on the contrary, generally not exceeding 2–3 H. The author himself maintains a certain reserve in respect to the use of stronger doses filtered by heavy metal, as to the disease.

From a clinical standpoint he divides the process of the lymphadenitis into three phases: (1) simple hyperplasia of the tuberculous glands, (2) formation of large glandular masses with periadenitis, (3) suppuration softening with fistulas and scrofuloderma.

The results of the irradiation for these phases are as follows:

All the observations comprise 206 cases, of which 70 belong to the first phase, 32 to the second and 104 to the third. Recovery (disappearance or atrophy of the glands with small fibrous remnants) in group (1) has been made in 70 per cent of these cases, in group (2) in 56 per cent, in group (3) 2 per cent; in 84, 6 per cent. An improvement has been made in 20 per cent, 28 per cent and in 5,6 per cent, embracing either cases with diminution of the lymphomata or those where the treatment was interrupted or not yet concluded. Fourteen cases of recurrences have been recorded (in 6, 7 per cent) of which 3 were from group (1) and 2 from group (3). There have been eight deaths. In calculating the total duration of treatment, a space has been reached varying from 6½ to 8⁸⁄₁₀ months for the different groups. In the cases belonging to group (1) the treatment has generally yielded a favorable result unless the lymphomata have already been strongly indurated. The great glandular masses with caseous degeneration take much time to resorb. In these cases the limits between groups (2) and (3) cannot be clinically established with certainty, but the gravity of the cases depends on the development observed during treatment, in this sense; that the latter facilitates suppuration, supposing that such a tendency exists. The softening can also occur in solitary and absolutely mobile glands.

In the event of suppuration the abscess is generally treated by incision, radical scraping and then tamponade for several days, after which the fistula is allowed to close. In suitable cases we endeavor to confine ourselves to punctures. If fistulas or scrofuloderma already exist, the treatment begins with scraping. The scars resulting from the incisions are often remarkably fine and equal. The soft lymphomata do not give a bad prognosis in radiotherapy; rather the contrary. A tardy softening can survive up to five years after the ceasing of the treatment.

A comparison with the surgical statistics of the lymphomata shows that radiotherapy furnishes a much higher percentage (77 per cent against 54 per cent after operation) and a lesser number of recurrences (30 per cent against 28 per cent of operation cases). On the other hand, the treatment by roentgen rays offers a certain risk of secondary lesions of the skin. The author has observed such in 36 cases, of which the half were, however, of very light nature. These lesions can, however, always be avoided by means of an appropriate technique. More serious lesions, such as atrophy of the skin with telangiectasia or pigmentation, are not included in the author's observations. By radiotherapy the patient avoids the unpleasantness of a serious operation, and the cosmetic result is often much to be preferred. The excellent results of irradiation show to the best advantage in cases where the surgeon has little success (abscess, fistulas).

On the other hand, the radiological treatment suffers from the inconvenience of being of long duration, frequently also combined with tiresome and expensive journeys, which is a matter to be taken into consideration where patients with limited means are concerned. Operation is preferable for solitary and mobile lymphomata without softening, as well as for cases where there are great masses of indurated glands that have not been reduced after a certain period of irradiation. A combination of universal light baths is often to be recommended, especially when diffuse, soft or fistulous lymphomata are in question, complicated by tuberculosis of the skin and a bad general condition.

Åkerlund, Åke. On a Device for the Diaphragming of the Secondary Radiation during Roentgen diagnosis. *Acta Radiol.*, i, Fasc. 4, pp. 480–486.

After an account of the various contrivances designed by Bucky, Lotzin and Potter for the diaphragming of the secondary rays in roentgen diagnosis, the author describes a new model of a movable secondary diaphragm which has yielded extremely promising results. This diaphragm has the shape of a rotating, flat, circular plate of transparent material on which a number of close-set, spiral leaden strips are applied parallel to each other and centered exactly in the center of movement, and which are at the same time adjusted in the plane of the primary ray, so that they converge towards the tube-focus.

Heyman, James. Results of the Treatment of Climacteric Hemorrhages by Radium Therapy in the Radium Clinic, Stockholm. *Acta Radiol.*, i, Fasc. 4, pp. 470–474.

From 1916 to 1921 there were 49 cases of non-complicated climacteric hemorrhages treated at the Radium Institute in Stockholm, Sweden. These cases were subsequently followed. All of them were treated by radium. Single treatments in 41 cases, of which 30 were intrauterine and 11 vaginal; in 7 cases, two treatments, and in 1 case, three treatments.

Result: Amenorrhea in 32 cases, oligomenorrhea in 16 cases. One case was unsuccessful.

Ernst, N. P. Results of Treatment of Surgical Tuberculosis with Carbon Arc-Light Baths Finsen's Light Institute from 1913 to 1921. *Acta Radiol.*, i, Fasc. 4, pp. 422–454.

At the Finsen Medical Light Institute in Copenhagen, on the initiative of Doctor Reyn, "Finsenbaths" (carbon arc-light baths) have been employed since 1913 for treatment of patients suffering from lupus or surgical tuberculosis.

In all, 439 patients suffering from surgical tuberculosis have been treated; 145 cases of uncomplicated tuberculosis and 294 cases of tuberculosis complicated with abscess or fistulas.

The results of the treatment have been remarkably good.

In 158 cases of uncomplicated tuberculosis in joints and bones 12 have broken off the treatment. Of the rest (146) 122 or 83 per cent were cured, 5 were improved and only 19 were unchanged.

In 396 cases of surgical tuberculosis complicated with abscess or fistulas, 24 have broken off the treatment and 10 have died under treatment. Of the remaining 362, 332 or 91 per cent were cured: 255 with free movement, 55 with partial movement and 22 without movement; 15 were improved and only 25 were unchanged.

As regards the results, one may remember that the greater number of the patients are adults (less than ⅓ are recruited from childhood) and further, many of our patients have been ill for so many years that *a priori* any thought of recovery had to be excluded. Furthermore it may be remembered that many of our patients, on account of lack of space, and much against our wishes, have had to be treated ambulantly, and during the treatment they have lived in their exceedingly poor homes.

The best results are obtained in cases of tuberculosis in hand, foot and elbow-joint, also in all forms of osteitis both complicated and uncomplicated. The cases which have proved refractory are the uncomplicated tendosynovitis, and the very old fistulous bone affections in columna pelvis and coxa.

Sears, Nathan, P. A New Method of Making Ureteropyelograms. *Surg., Gynec. & Obst.*, Feb., 1923, xxxvi, 274.

A wax spindle about 2.5 to 3 mm. in diameter is placed on the whistle tip catheter about 1 to 1.5 cm. from the tip. The catheter is threaded back through the cystoscope in the usual way of passing wax tips (described by Harris and also by Hinman). The instrument is then introduced, the catheter with the bulb is passed into the ureter to be studied so that the bladder wall holds the bulb. This permits the tip of the whistle tip catheter to enter the ureter. The other side is catheterized and urine collected from each for study. The patient's shoulders are elevated slightly and a 14 × 17 *x*-ray plate is placed under the back so that it inclines downward at an angle of about 10 to 15°. The ureter and pelvis are then gently filled in the usual manner.

If the patient is flat on his back the upper ureter does not fill, probably due to the fact that the fluid, after crossing the iliac crest, flows rapidly to the pelvis and produces the pain of distention, prohibiting further injection. The Trendelenburg position permits the kidney to fall upward and thus disturbs its casual position and does not give true information. After the exposure the catheter may be passed up; or, if the bulb interferes, another catheter in place of the opposite one, which can be removed, is passed to drain the fluid. However, the fluid usually flows back more quickly with the catheter low in the ureter than with the older method.

By this technique accurate information regarding stricture or kink can be obtained and obscure causes of pain located.

Strauss, A. The Problem of Radium and Surgery in the Treatment of Cancer. *Ohio M. J.*, Feb., 1923, xix, 85.

The author advocates the following methods: Because of the high operative mortality, the mutilating operation, to which few will submit, and the low percentage of cures, cancer of the tongue is a disease to be treated by radium to the local lesion and radium and operation to the glands of the neck. This also applies to recurrences and carcinoma of the lower lip. Carcinoma of the breast is still considered a surgical disease and radium and *x*-ray are to be used as aids. In fundus growths heavy doses of radium should be applied intrauterine to stop the growth of the cells in the uterus before hysterectomy. Radium is gradually finding an extended field in both operable and borderline cases of cancer of the cervix. Because recurrences do not take place in the uterus but in the parametrium and glands, no case of cancer of the cervix should be removed after raying. Radium is effecting nearly the same percentage of cures in cancer of the rectum as surgery, but a preliminary colostomy is necessary to avoid unbearable pain.

de Courmelles, Foveau. Radioanaphylaxie. *Arch. d'électric. méd. et de physiothérapie*, Nov., 1922, No. 482, p. 327.

The field of radiation therapy is similar to those of the application of medicaments and of foods, in that idiosyncrasies actually make themselves apparent. In the early days of *x*-ray work, in 1896, A. Soret, of Havre, noted immediate burns, dermatitis, epilation; in fact, an entirely new "radiopathy" due to the radiations.

The apparatus used then was very weak and was employed more or less in the same fashion for all patients, with long applications; but on the whole, patients were burned very little. It seems, therefore, well to admit that there may be a special sensibility, an idiosyncrasy, today called radiosensibility.

On the other hand, some patients (or rather, the majority of patients, because radio therapy of fibroma came quickly) stood the first treatments very well, while, when treatment was omitted for a certain time, on resumption of treatment violent general or local reactions were frequently noted. This could not be explained as a cumulative effect, and for lack of a better explanation this radiopathy was called radiation sickness (A. Béclère).

The author goes into an extensive discussion of the untoward effects of radium and *x*-rays upon patients, physicians, and technical workers, and concludes that, whatever its nature, radio anaphylaxis does exist. He suggests that some day there will be discovered a means of desensitizing radiologists and others who are subject to it.

Béclère, M. Existe-t-il des Fibro-Myomes de l'Utérus Réfractaires à la Roentgenthéraphie? *Arch. d'électric. méd. et de physiothérapie*, Dec., 1922, No. 483, p. 362.

The author claims that before the natural menopause, especially in young women, the ideal in the treatment of uterine fibroids would be to destroy the lesion while conserving the organ and its function. This ideal is occasionally realized. Nearly always it is necessary to pursue the treatments until the periods have been suppressed. This suppression and the hot flashes which accompany it are in the great majority of cases the indication of cure. At this time all loss of blood has ceased and the fibroids, which have already more or less notably diminished in volume, continue to retrogress and occasionally disappear completely. Sometimes, in spite of the suppression of the menstrual function, the losses of blood persist more or less abundantly and always irregularly. The question brought up in this connection is, therefore, subdivided into two parts:

1. Does roentgenotherapy always bring about suppression of the periods with more or less notable retrogression of the myoma?
2. Does roentgenotherapy always cause the cessation of all loss of blood?

The first question is answered in the affirmative, not only because in his series of 700 observations the author has always obtained suppression of the periods with more or less notable diminution in the size of the tumors, but also because in patients who have undergone long treatment without success by well-known or even renowned radiologists, who have without doubt not given a sufficient depth dose, the author has, with correct technique obtained the desired result. By way of illustration he reports 10 such cases, of which 7 had been treated with the *x*-rays and 3 with radium.

The answer to the second question, according to Béclère, is not so definitely affirmative. When the losses of blood persist after suppression of the periods—these losses not being due to the exceptional coincidence of an epithelioma of the intrauterine mucosa which demands hysterectomy, or to the presence of a polypus which requires vaginal excision—these bloody losses sometimes cease of themselves without further irradiation; although in other cases, when they are more abundant and more frequent, they necessitate persistence in the treatment, finally disappearing under its influence. However, there is a small group of cases which, in spite of repeated treatment, finally require surgical intervention. This has been observed by Béclère seven times in 700 cases. In these seven cases hysterectomy was successfully performed and revealed in the cavity of the uterus a submucous fibroid of greater or less size, without any other lesion of the mucosa. In spite of these seven cases, the author insists that the presence of submucous fibroids is not a contraindication for roentgenotherapy.

Nogier, Th. Traitement de l' Hypertrophie Amygdalienne par les Rayons x. *Arch. d' électric. méd. et de physiothérapie*, Dec., 1922, No. 483, p. 364.

The author gives a brief history of the method described in 1913 by himself and Regaud for the treatment of tonsillar hypertrophy.

Soft hypertrophied tonsils in which the overgrowth of tissue involves the lymphatic follicles, that is, the lymphoid tissue, constitute the only form of hypertrophy in which the *x*-ray treatment is truly useful.

The results are very satisfactory and there have been noted no recurrences when the dose was sufficient.

Radiotherapy is a mode of treatment which is painless, which does not expose the patient to any complications, and which is not accompanied by any risk of fatal hemorrhage. It is the only method to be employed in hemophilia and nephritis, and for infants below the age of four years.

Ledoux-Lebard. Le cancer des radiologistes. *Paris méd.*, April 8, 1922.

The author discusses the cancer that develops on a chronic radiodermatitis, which, like all persisting irritations, favors the development of cancer. He believes that it is rather frequent to find this malignant transformation occurring in chronic radiodermatis—20 to 30 per cent of cases. Clinically he distinguishes two varieties: (a) the verrucous form; (b) the ulcerating form. The malignancy of this type of cancer is very great, causing 15 cases of death out of 77 observations. The appearance of this lesion is similar to the appearance of the lesions of the chronic radiodermatitis which surrounds it. There are no special characteristics, either clinical or histological, to differentiate the lesion, and error is therefore easy.

The treatment should be especially directed to prevention, because with reasonable precautions the disease is preventable. In the younger generation of radiologists these professional radiodermatitis lesions are exceptional. Epithelial verrucosities should be destroyed, as, for instance, by carbon dioxide snow. Roentgen therapy has given some good results, but it is especially with radium that the author has seen complete cures.

Lilienthal, Howard. Resection of the Lung for Suppurative Infections. *Ann. Surg.*, Mch., 1922, lxxv, 257.

This interesting article contains a section on bronchoscopy and *x*-ray examination. Within limits, the more one knows of the location and character of the disease before operating the better. But though the author heartily favors bronchoscopy, it need not be employed in every case. After all, the chest is to be opened, and opened widely, and conditions may then become apparent that could not possibly have been predicted. The really necessary things to know are (1) whether the disease is in the upper or the lower part of the chest; (2) whether it is near the hilum or near the periphery; (3) whether there is perhaps a foreign body or a tumor present in the bronchus as a cause of the suppuration.

The *x*-ray may show all these things. In making roentgenograms in all chest cases the upright position is the best for completeness. The diaphragm is low and the chest capacity greatest. In the prone or supine posture the diaphragm is crowded upward by the abdominal viscera, and in its turn, distorts the appearance of the thoracic organs. Level lines in the presence of air and fluid cannot be seen when the patient is recumbent with the rays passing from front to back or vice versa. When the patient cannot be placed upright, the exposure may be made anteroposteriorly while he lies on his unaffected side. Fluid levels may thus be demonstrated, and by taking the picture in both positions the size of the cavity can be estimated, and unsuspected ones may be discovered.

Sometimes, however, bronchoscopy will reveal what the *x*-ray cannot disclose. For instance, the *x*-ray may show a triangular shadow and the history may indicate the presence of intrapulmonary suppuration; but the bronchoscopist may find and remove an aspirated lemon seed, radiotransparent, which caused all the trouble. Also, it may be convenient to know whether the pus is coming from one or more lobes when the *x*-ray shadow leaves one in doubt: this more as a matter of prognosis than influencing technique.

Bailey, Harold, and Quimby, Edith. The Use of Radium in Cancer of the Female Generative Organs. *Am. J. Obst. & Gynec.*, Feb., 1922, iii, 117.

This paper describes the Memorial Hospital technique for the employment of radium in cancer of the female generative organs, and is a collaboration between the gynecological and physical departments.

The history of the work is carried back to January, 1915. Tables, photographs and drawings are given showing the employment of the "bomb" with which the authors have been able to give as high as 3,000 mc. hours of radium treatment in the vaginal vault with but little irritation of the bladder and the rectum.

The original article contains full details which are well worth study. The full technique, using the external radiation as an aid to the capsule and bomb, was not in routine use until 1918. If the advanced primary cancer and the recurrent cancer groups are taken together, there were 132 cases treated previous to January 1, 1918, and there are but 5 cases alive today. If these same groups are taken for 1918, there are 76 cases, and 15 are alive; for 1919, 112, and 40 living; for 1920, 129, and 85 still alive. While the prospects of greatly reducing these figures are present and sure, nevertheless, the indications are that in these groups the greatest advance has been made.

The follow-up of the operable and borderline classes will have to be continued through three or four more years before deductions may be made. The author's present figures are remarkable and indicative.

In the prophylaxis after hysterectomy great care must be used that the tissues are not overradiated. The end results in this class are very good for the time elapsed since treatment.

Coffey, Robert C. Treatment of Cancer of the Rectum. *Ann. Surg.*, Oct., 1922, lxxvi, 500.

The author recognizes surgery as the principal method of treatment of cancer of the rectum. For obvious reasons the cautery may be eliminated except in the lower two inches, and even there is has no advantages. In the opinion of the author, the application of the *x*-ray is impractical owing to the anatomical location of the lesions. It is interesting to note the author's conclusions regarding radium, in which he has been greatly disappointed and for no reason which he is able to explain, in view of the remarkable success of radium in the treatment of cancer of the uterus.

Hochenegg's clinic reports more than 700 cases of cancer of the rectum treated. Of these, 28 were treated with radium and only one gave good results. Many were made very uncomfortable and were worse than if no treatment had been given.

Coffey reports 8 cases in which he employed radium in connection with a preliminary colostomy, the radium being drawn immediately into the growth as accurately as it could be done in carcinoma of the cervix. In some of the cases a rectal tube was passed down through the colostomy opening and out through the rectum. Radium tubes were arranged in tandem in the rubber tube. An annular pack of gauze was sewed around the tube just partially covering the lower tube of radium. This circular pack of gauze was for the purpose of stopping the tube in the growth as it was drawn upwards. Gauze was then packed in the rectum below this and a safety pin passed through the end of the tube as it emerged from the colostomy opening. In cases where the growth was strictly limited to one wall of the rectum, a sheet of lead was placed on the opposite wall for its protection. In one case of very extensive cancer of the lower rectum, the growth apparently was temporarily killed. An annular scar took its place. Owing to the advanced condition of the disease, the patient died within a few months with extension farther up in the pelvis. No other patient was even temporarily cured or made more comfortable. Several of the patients suffered unspeakable pain, apparently the result of the radium. This pain was either in the back or in the bladder, or both.

The author concludes that he will never use radium again in cancer of the rectum, except for some very extradorinary reason, and this statement is made in face of the fact that he is very enthusiastic in recommending radium in cancer of the uterus, even to the point of almost excluding radical surgery in carcinoma of the uterus.

Lane, Laura A. A Study of the Tonsil Question with a Preliminary Report of Roentgen-Ray and Radium Therapy in the Treatment of Pathologic Tonsils. *Minn. Med.*, Feb., 1923, vi, 97.

The author has summarized studies covering observations of more than 30,000 patients. These indicate that after one to four years subsequent to operation permanent results are manifest in only about one-half the patients. The tonsil has some function, according to this author, and more effort should be made to preserve the tonsils, especially in children. Greater care should be taken in studying patients with tonsil disease and in selecting cases for operation.

During the year ending September 30, 1922, the writer had under treatment and followed up 52 patients treated with roentgen rays and 24 treated with radium or both combined. Careful bacteriological studies were made of many of the cases, showing a decided lessening of the number of bacteria. In several cases the streptococci were entirely absent as long as ten months after treatment. The author does not claim that radiation will do away entirely with the bacteria, but mechanical drainage established through skrinkage and narrowing of the crypts is beneficial in reducing the bacterial flora of the tonsils and nasal pharyngeal tissues.

In the author's series there were four cases with notable thyroid enlargement. In all, improvement in the size of the thyroid has been noted. The author's results have been most striking in children and adults of a decided lymphoid hyperplasia type; also in patients with cervical adenitis associated with tonsil pathology.

Chizzola, Giuliano. Su Due Casi di Lussazione Palmare Totale dell' Osso Semilunare. *Radiol. med.*, Dec. 12, 1922, ix, 512.

The author gives a very extensive review of the literature on the subject from the *x*-ray standpoint and a number of illustrative cases, including two new ones. An excellent bibliography is appended to the article.

Moore, C. N. Physical Principles Underlying the Development of High Voltage Roentgen-Ray Apparatus. *Arch. f. Dermat. u. Syph.*, Oct., 1922, vi, 455.

This is an excellent presentation of the physical basis of deep roentgen therapy. Among other things, the author declares that at 40,000 volts the shortest wave-length is about 0.3 Å, and this decreases to about 0.1 Å at 90,000 volts. At the same time, the intensity of the waves of shorter length has tremendously increased. There are still a lot of long wave-lengths present, however. The same thing holds true as we go to still higher voltages. At 165,000 volts, the shortest wave-length is 0.075 Å. The wave-length of the gamma rays from Ra-C is approximately 0.004 Å. According to the work of Ellis in England, it would require a voltage of 3,000,000 on the tube to produce roetngen rays of this short wave-length. It is evident from these measurements that increasing the potential applied to the tube results in the production of a greater quantity of more penetrating rays. A number of interesting graphics are presented which should interest anyone practicing roentgen therapy.

THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. X MAY, 1923 No. 5

CARDIAC PNEUMOFIBROSIS*

BY GEORGE W. HOLMES, M.D., AND DAVID S. DANN, M.D.

X-Ray Laboratory, Massachusetts General Hospital

BOSTON, MASSACHUSETTS

INTRODUCTION

ALTHOUGH there has been a definite advance in the accuracy of interpretation of the radiographic findings in diseases of the chest during the past few years, the shadows appearing at the hilus and along the course of the bronchial tree are still a source of considerable confusion. It was in an attempt to explain some of these doubtful shadows that this study was undertaken.

We shall not discuss all of the various pathological conditions which may produce an increase in hilus and peribronchial density, but will mention only those which are known to produce fibrosis, and discuss more completely the pathology of the lungs and the radiographic appearance produced in chronic pulmonary congestion.

While it is generally known that the clinical picture in cardiac pneumofibrosis, particularly when it is the result of valvular disease of the heart, may simulate closely that of tuberculosis of the lungs even to the extent of hemorrhage, we have been able to find very little reference to the similarity of the radiographic appearances.

REVIEW OF LITERATURE

Barjon[1] devotes a chapter to the changes in the lung due to vascular processes. He divides them into primary active congestion, secondary active congestion, passive congestion, edema and infarcts. Most of the text is given to a description of the acute process which gives a diffuse radioscopic shadow seen at the bases of the lungs somewhat resembling pneumonia. No illustrations are given.

Overend[2] reports a case with a radiograph showing the characteristic mitral configuration of the heart and increased density in the hilus and perihilus region. In discussing this case, he states that both pulmonary fields are pervaded by the fine mottling of diffuse fibrosis.

The following description (accompanied by two characteristic radiograms) from Assmann[3] is the best we have found in the literature:

"Stasis of blood in the capillaries and smaller veins of the lungs causes certain changes in the roentgenogram. These changes are seen in decompensation, particularly in mitral regurgitation, and also in myocarditis and other conditions affecting the left ventricle. The film in these cases has a sort of 'washed-out' appearance which gives the impression at first glance of its being badly exposed or faulty. The most marked case of this disturbance of the lung picture which I have seen is one of mitral stenosis in which there had been repeated attacks of severe hemoptysis. Another sign of pulmonary congestion which may not run exactly parallel to the amount of clouding of the lung fields is a broadening and increased prominence of the normal lung markings which are made up of the larger and medium-sized bloodvessels. Accompanying this there is also increased prominence of the smaller markings lying adjacent.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

"These increased markings run from the hilus toward the periphery, and they decrease uniformly in size and intensity as they go outward, for we are dealing with a condition which affects the blood-vessel system as a whole. In this respect this condition differs from the discrete shadows which are due to increase in the size of the lymphatic glands or local thickenings of the bronchial wall as seen in bronchiectasis.

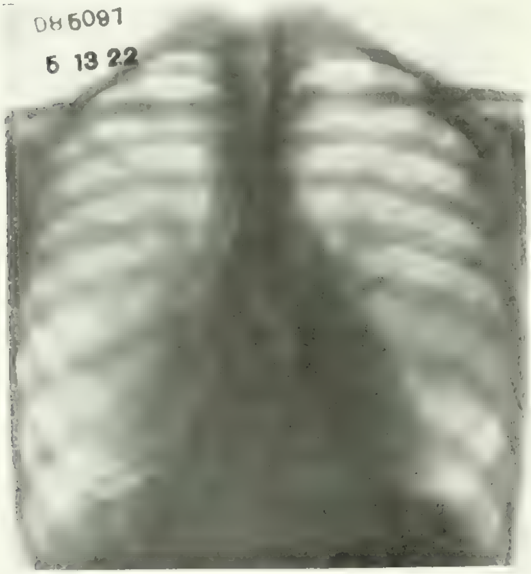


Fig. 1. Rheumatic heart disease with mitral stenosis in a child fourteen years of age. This plate shows the "washed-out" appearance characteristic of cardiac pneumofibrosis, marked increase in the hilus shadow and a general thickening and mottling of the larger lung markings (with the typical mitral shape of the cardiac shadow), making the picture a very typical one.

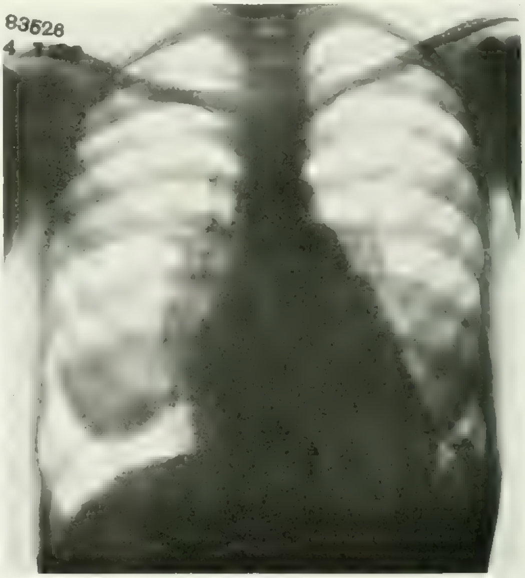


Fig. 2. Mitral stenosis and insufficiency in female aged twenty-six. The cardiac shadow shows the typical mitral deformity. There is a marked increase in the root shadows on both sides, with definite increased density along the linear markings extending well out from the periphery of the lung. This represents a case in which the changes in the lungs are not marked.

"This increase in the hilus shadows and of the blood-vessel markings radiating out from the hila in cases of pulmonary congestion has given the erroneous impression of its being peribronchial or lymphatic tuberculosis."

Stillman,[4] in discussing the clinical manifestations, states that when the heart is compensating, it produces no symptoms, but with failure of the cardiac muscle there is dyspnea, cyanosis and cough. The dyspnea is ascribed to diminished elasticity of the lung and the narrowing of the alveoli. The cyanosis usually parallels the cough and dyspnea intensity. The cough may be very annoying and bring up a moderate amount of sputum. Blood is quite commonly present, usually as streaks or small masses. The physical signs are not at all clear cut. There may be dullness, and moist rales at the bases, or, at times, no deviation from the normal can be made out.

Robinson,[5] in a description of mitral disease, states that the early and most characteristic effects result from disturbances of the pulmonary circulation. Paroxysmal attacks resembling asthma are sometimes seen. Cough, with expectoration sometimes bloody or blood-streaked, accrues. Hemoptysis is not uncommon. Bronchitis is a frequent complication. The signs of this condition and other pulmonary signs lead to confusion at times between mitral stenosis and tuberculosis.

THE PATHOLOGICAL AND RADIOGRAPHIC FINDINGS

Before discussing the radiographic findings in cardiac pneumofibrosis, it is desirable to review its pathology.

According to MacCallum,[6] macroscopically the lungs are rather pale, sometimes dry, sometimes edematous, dense, elastic and of a distinct rusty brown color.

Microscopically the capillaries in the alveolar walls become greatly dilated and tortuous, so that they project in loops into the alveolar cavities. The alveolar epithelium and other cells are desquamated into the air cells; fluid exudes from the tense capillaries, often with red blood-corpuscles. The smooth muscle in the septa that forms the vestibules in each lobule is greatly increased in bulk, and the alveolar walls in extreme cases become thickened and indurated by the appearance of new connective tissue (brown induration of the lungs).

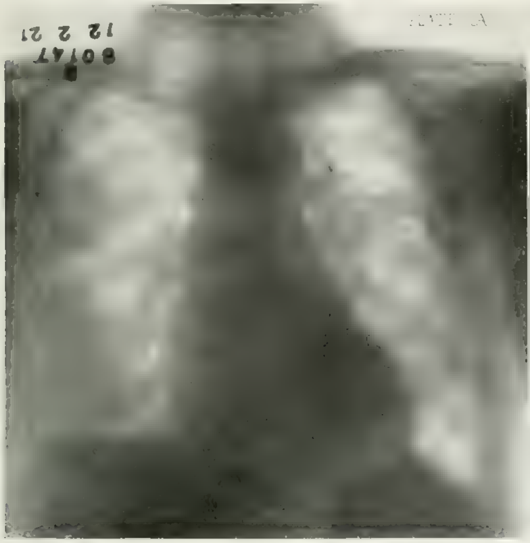


Fig. 3*a*. Cardiosclerosis, auricular fibrillation, myocardial insufficiency, with extensive changes in the lungs. Physical examination showed coarse moist rales at both bases, and dullness and diminished breath sounds at the right base. The plate has the general hazy appearance characteristic of cardiac pneumofibrosis, with the marked increase in the hilus shadows and general thickening along the course of the bronchi. The unusual appearance in this case is the areas of sharply defined increased density in the right chest and the high flat diaphragm on the right side. This could be interpreted as being due to changes in the pleura.

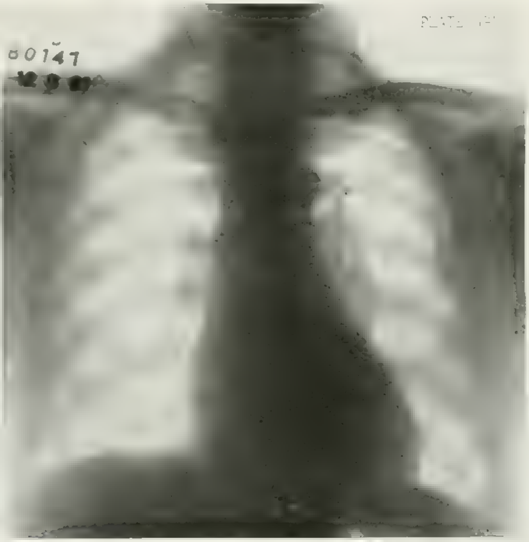


Fig. 3*b*. Cardiosclerosis, auricular fibrillation, myocardial insufficiency, with extensive changes in the lungs. This plate, taken of the patient six days later, shows complete disappearance of the areas of density in the right lung. At this time, the patient's cardiac condition had returned to normal.

The extent of change from the normal as seen with the *x*-rays varies widely, depending upon the severity and duration of the disease. Early changes are seen at the hilus, and as the process progresses they extend outward along the bronchial tree into the lung fields. In advanced cases the entire lung area may show these changes. The characteristic finding is an increase in size and density of the hilus shadow. The borders of this shadow are hazy and indefinite. Radiating outward from it, the lung markings are increased in width and density, but without beading. The surrounding lung tissue is less radiant than normal so that the markings appear hazy and indefinitely defined. These changes may be accompanied by irregular areas of even density of rather large size, and indefinite borders which are most frequently seen in the lower part of the chest around the descending bronchi. There is also occasional coarse mottling between the shadows of the bronchial tree. The outline of the diaphragm is usually well defined but its respiratory movements are frequently limited. The size and shape of the heart shadow are of considerable importance in arriving at a correct diagnosis, as the condition in the lungs is due to failure of the pulmonary circulation. The lung findings are invariably accompanied by an abnormal appearance of the cardiac shadow, the mitral configuration being the most common.

DIFFERENTIAL DIAGNOSIS

The lung picture of cardiac pneumofibrosis is likely to be confused with dust pneumofibrosis, metastatic carcinoma and tuberculosis.

After reaching the axillary nodes and the muscular aponeurosis, mammary cancer usually becomes generalized and nearly any tissue in the body may become involved.

The lungs are reached superficially from the pleural lymphatics, while from the bronchial nodes extensions pass along the lymphatics of the blood-vessels. Extension to lungs through the blood-vessels is rare.

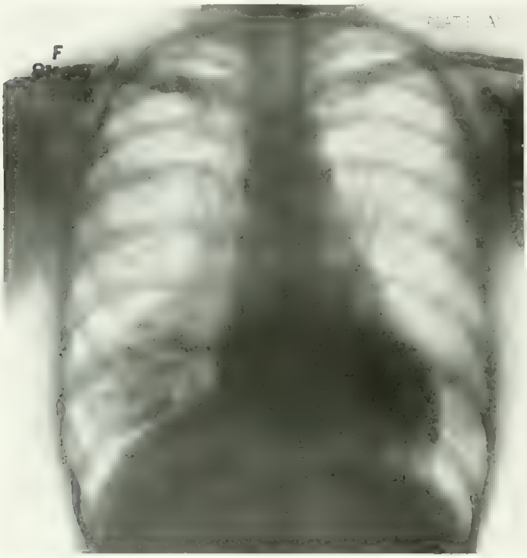


Fig. 4a. Mitral stenosis and aortic regurgitation with pulmonary tuberculosis. In the clinical picture, the cardiac condition predominated and the patient apparently died a cardiac death. In this plate there is marked increase in the hilus areas and a general haziness and thickening of the lung markings characteristic of pneumofibrosis. The process extends into the apex on the right side, and there is an area of markedly increased density near the right root.

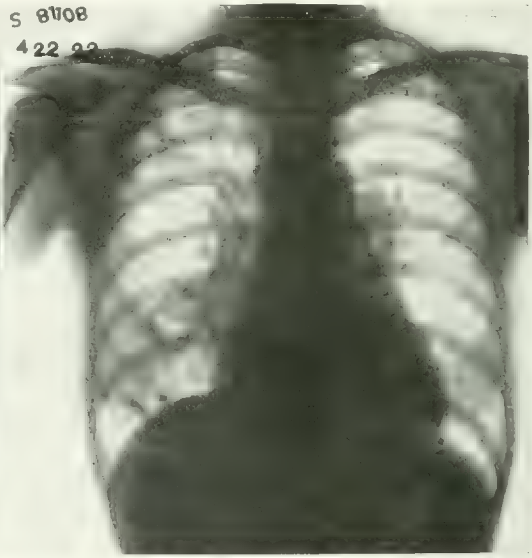


Fig. 4b. Mitral stenosis and aortic regurgitation with pulmonary tuberculosis. This plate, made of the patient three months later, shows a distinct increase of the process at the apex and a suggestion of cavity formation in the dull area at the base. At this time tubercle bacilli were found in the sputum.

In the radiograph, the lungs in malignancy present several distinct types which have been described by Carman, Pfahler, Crane and others.

The type with which we are interested is that in which the deep mediastinal glands are involved, and the process spreads outward along the bronchial tree.

In the enlargement of the hilus shadow due to malignancy, the shadows are likely to be more irregular and more sharply defined. The distribution along the bronchial tree is more irregular and the process is not likely to be more marked in the lower than in the upper lobes. The heart is usually of normal size and contour.

In dust pneumofibrosis, the macroscopic picture varies according to the character and quantity of the dust to which the lungs are exposed; and the amount of fibrous tissue apparent on the cut surface of a lung depends on the length of time the process has been going on. In the early stages, practically none can be seen by the naked eye; in the advanced stages, the smaller vessels and bronchioles are distended and stand out, surrounded by dense fibrosis, in which are embedded the dust particles. In this stage, the lungs may show emphysematous blebs, bronchiectatic dilations, and collapsed areas. One of the most striking features of the gross anatomy is the black glands at the hilus and the formation of nodules in the lymph channels.

The essential differences as seen on the radiograph are the more even distribution of the densities throughout the lung fields, the absence of marked enlargement of the hilus shadow and the normal cardiac shadow.

Aside from the pneumonic patches following bronchial transportation, there is a great variety of anatomical lesions in the lung which is due to the passage of tubercle bacilli along the lymphatics or blood-vessels.

When the infection is through the lymphatic channels the bacilli produce tubercles in strings or clusters along the interlobar septum in the bronchial walls or in the walls of the blood-vessels. It is this type which is most likely to be confused with cardiac pneumofibrosis. In tuberculosis there is more definite beading and the markings are more sharply outlined. The general haziness of the lung field is absent. The cardiac shadow may or may not be normal. Ring-like shadows or areas of diminished density due to cavity formation and retraction of the mediastinal contents may be present. These latter findings are never seen in the fibrosis of cardiac lesions.

In general, the differentiation of cardiac pneumofibrosis from other forms of pneumofibrosis will depend upon the study of the cardiac shadow, the general hazy appearance of the lung field and the absence of evidence of destruction and retraction in the lungs. In this disease, as in most lung conditions, a correct interpretation of the radiographic findings will depend usually upon a knowledge of the clinical history and physical examination.

The following histories are illustrative of the cases studied:

Case I. (No. 85,097.) Female, aged fourteen.

Clinical Diagnosis. Rheumatic heart disease with mitral stenosis? Consolidation at right base.

Present Illness. May 11, 1922. One year ago, patient was sick for one month with pneumonia. Ever since she has had marked dyspnea on exertion. Has had no cough, pain or edema. No history of tonsillitis, rheumatic fever or chorea. Has tachycardia on exercise. She has been able to continue with her school work.

Personal History. Tonsillectomy and adenoidectomy five years ago.

Physical Examination. Thin, pale and only fairly well developed. Throat and teeth are negative. Pulse is 100 and is regular in rate and rhythm. *Heart.* Left border dulness is 10.5 cm. in the fifth space. P_2 is accentuated. No murmurs or thrills in aortic area. In the mitral region, there is a systolic and presystolic murmur and a sharp first sound; a thrill could be felt. *Lungs.* There is slight dulness and squeaky rales at the right back from the base to just below the angle of the scapula. *Abdomen.* No fluid; liver dulness from fifth space to costal margin. *Extremities.* No edema.

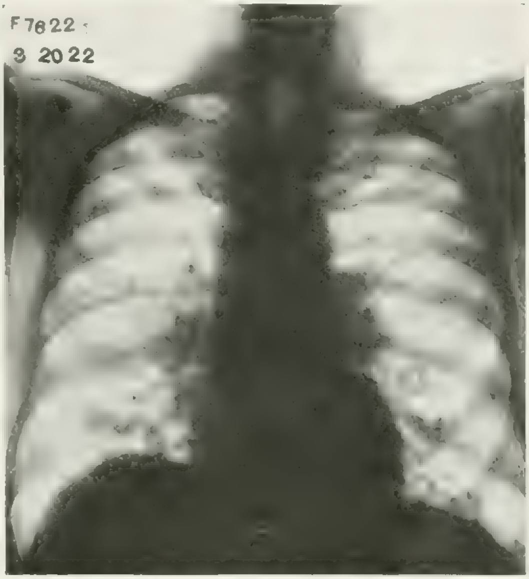


Fig. 5. A case of metastatic malignant disease of the lung from a carcinoma of the bladder. The plate shows the irregular increase in the hilus shadow and larger markings occasionally seen in this disease. Note that the shadows are more irregular and more sharply defined than in cardiac pneumofibrosis.

Note from Cardiac Clinic. May 18, 1922. A case of rheumatic heart disease with mitral stenosis. Respiratory infections, chronic, following pneumonia (?) of tuberculosis.

Appears to be more than a chronic passive congestion. ℞ To have repeated sputum examinations and temperature taken morning and evening. Referred to pulmonary clinic.

May 26, 1922. No tubercle bacilli found in the sputum at three different examinations. Patient has had no fever. The case appears to be one of cardiopulmonary fibrosis.

X-Ray Findings. May 13, 1922. Thickening at the lung roots without evidence of calcification, and increase in density of the larger bronchial markings. Apices and periphery are relatively clear. Appearance may be due to lymphatic engorgement and pulmonary congestion secondary to the heart condition. Prominence of right auricular arc particularly marked in oblique view. Left ventricular arc flattened, apex pointed and displaced downward. Enlargement of heart particularly in region of auricles suggesting predominant mitral lesion.

Case II. (No. 83,526.) Female, aged twenty-six.

Clinical Diagnosis. Mitral stenosis and insufficiency--aortic insufficiency—secondary anemia.

Consultation Clinic. Apr. 6, 1922. Dyspnea and precordial pain.

Present Illness. In 1918, four years ago, patient was sick for five weeks with double pneumonia. After this illness, she tired easily, had a persistent unproductive cough, and dyspnea on even the slightest exerotin. Has had no edema or palpitation.

Family History. No history of exposure to tuberculosis.

Personal History. Always well until her attack of pneumonia five years ago.

Physical Examination. Chest. Lungs clear. *Heart.* Left border dulness, 9 cm.; right border, 4 cm. Sounds regular, slow and forceful. P_2 and A_2 accentuated. Short presystolic murmur at left apex and a diastolic at left sternal border. *Abdomen.* Negative.

Summary. A fairly well compensated cardiac entering hospital because of dyspnea and precordial pain. The signs are those of mitral stenosis with moderate degree of aortic regurgitation.

X-Ray Findings. Apr. 7, 1922. The outline of the diaphragm is well defined on the right; a little hazy on the left. Its movements are distinctly limited on both sides. The heart shadow is increased in all diameters, the greatest increase being across the base. There is marked prominence of the shadow of the auricles, particularly the left, giving the heart the typical mitral shape. The hilus shadows are very much increased both in size and density on both sides. All of the larger lung markings are also increased in size and density. Both lung fields have a general hazy appearance. The apices are clear.

Case III. (No. 80,147.) Male, aged sixty.

Clinical Diagnosis. Cardiosclerosis—auricular fibrillation—myocardial insufficiency.

Consultation Clinic. Nov. 30, 1921. Dyspnea and palpitation.

Present Illness. Four months ago, after an operation for hemorrhoids, had sudden shortness of breath. Because of the increasing dyspnea, he was forced to give up his work after one week. Has had no edema. Has had a sense of constriction with dull pain in the left chest, shoulder and arm.

Present History. "Always well and strong." Syphilitic rash in 1887. No history of tuberculosis in family.

Physical Examination. Chest. There are coarse moist rales at both bases, and dulness, diminished breath and voice sounds at the right base. (?) of slight dulness at the left apex posteriorly. *Heart.* Left border dulness, 10 cm. Sounds rapid and irregular. No murmurs or thrills. Marked pulse deficit. *Abdomen.* Liver felt 1 cm. below costal borders, otherwise negative.

Dec. 7, 1921. Patient suddenly returned to normal rhythm, Discharged to local medical doctor.

X-Ray Findings. Dec. 2, 1921. The hilus shadows and lung markings are prominent. Both lung fields are less radiable than normal. Lateral half of right chest shows homogeneous density from the second rib to base. The median border of this area has a rather well defined wavy outline. Both diaphragmatic shadows are irregular in outline and markedly restricted in their respiratory excursion. Both costophrenic angles are obliterated. There are dense white lines extending outward from the hilus toward the chest wall. No marked change at extreme bases. Appearance is not that of tuberculosis. Heart shadow is enlarged; supracardiac dulness is slightly increased.

Enlargement of heart is more to the left than right. There is definite prominence of the ascending aorta.

Dec. 8, 1921. The shadows described in the right chest have entirely disappeared. Diaphragm is still high on the right side with partial obliteration of the costophrenic angle. Markings in the lung are generally thickened.

CASE IV. (No. 81,108). Female, aged thirty.

Clinical Diagnosis. Pulmonary tuberculosis—mitral stenosis—aortic regurgitation.

Present History. Apr. 20, 1922. Patient felt perfectly well and had no dyspnea or cough until onset of present illness—health always good.

Present Illness. On Jan. 2, 1922, while stepping off a street car, she suddenly coughed and spit up about a tablespoonful of bright red blood. There was no pain. She continued work, and one week later she coughed up blood again (ounces) five successive times in one hour. Two weeks ago she caught cold and had hacking cough with thick clear sputum since. Not breathless, but she states she climbs not more than one flight of steps without resting; no night sweats, chills or fever, no gastrointestinal or genitourinary symptoms.

Family History. She has had no exposure to tuberculosis.

Physical Examination. Extremities and lips are cold and blue. In no apparent respiratory distress. *Glands.* Moderate sized mass of freely movable non-tender glands in left neck; also large axillary glands. *Lungs.* The apices are retracted. Over the left apex, there is diminished tactile fremitus and the breath sounds are bronchovesicular to bronchial. Over the right apex, there is bronchial breathing and increased vocal fremitus. There are sticky rales over both backs. *Heart.* P_2 and A_2 accentuated; diastolic murmur at apex with harsh systolic. In the aortic area, there is a systolic ending in a loud A_2, with a high-pitched diastolic-presystolic thrill at apex. Blood pressure is 90/100. *Abdomen.* The liver edge could not be felt. Spleen felt 1 cm. below costal border. There are no masses or fluid.

Summary. Hemoptysis four months ago the initial symptom, but had no cardiac symptoms, though she was found to be a well-marked mitral stenosis. For past two weeks, she had cough and large amount of sputum. The physical examition shows loud diastolic and presystolic murmur at apex and a harsh systolic murmur at the base with a diastolic murmur along the left sternal border. This case appears to be mitral stenosis with aortic stenosis and regurgitation. The lungs are filled with sticky rales posteriorly, which did not appear to be due to pulmonary edema, for she was able to lie down with complete comfort. It is an infectious process which is very suggestive of tuberculosis.

May 5, 1922. The social service reports that the patient took a long walk on April 29th and became very weak and dyspneic. Two days later, she was found unconscious in the morning and died fifteen minutes later.

X-Ray Findings. Jan. 7, 1922. The diaphragmatic shadows are regular in outline. The diaphragm moves equally but poorly. The chest is of the ptotic type. There is coarse mottled dulness along the bronchi on both sides, but it is most marked in the right lower chest. In the right upper lobe, the changes extend to the apex. The process seems to be bronchial and peribronchial in type. In some plates a suggestion of dilated bronchi can be seen. There is no definite evidence of cavity formation. The heart shadow is distinctly enlarged, the increase being almost entirely downward and to the left in the region of the ventricle. There is an extensive pathological process in both lungs.

Jan. 13, 1922. The findings are practically the same as previously recorded. There is a definite process in the right lung which is more evident in the lower than in the upper lobe.

Apr. 22, 1922. There is a definite increase in the hilum shadow on both sides. The apices do not light up. Both upper lobes appear mottled, the right more than the left. At the right base there is a ring-like shadow with dense periphery and light central area and irregular increased density in the surrounding lung. There is a sharp upper border in the region of the interlobar septum. The right diaphragm is fixed; the left, free. The process has extended rapidly since the previous observation. It now shows evidence suggesting cavity formation in the lower right side.

BIBLIOGRAPHY

1. Barjon, F. Radio-Diagnosis of Pleuro-Pulmonary Affections. English translation by James A. Honeij. New Haven, 1918.
2. Overend, Walker. The Radiography of the Chest. Vol. I., Pulmonary Tuberculosis. St. Louis, 1920.
3. von Assmann, Herbert. Die röntgen-diagnostik der inneren erkrankungen. Leipzig, 1921.
4. Stillman, Ralph G. Passive Congestions of the Lungs. Nelson Loose-leaf Med., New York, p. 468.
5. Robinson. Nelson Loose-leaf Med., New York, p. 468.
6. MacCallum. Mechanical effects of experimental mitral stenosis and insufficiency. *Johns Hopkins Hosp. Bull.*, 1906, pp. 17, 260.

DISCUSSION ON PAPERS OF DRS. HALL, CHILDS, HOLMES AND DANN*

Dr. Moore. These two papers interest me very much. I was particularly interested in the papers of Dr. Hall and Dr. Childs about malignant growths within the chest. In 1915 I reported a series of 70 cases of secondary malignant growths within the chest. At that time we considered practically only the nodular type of metastasis. We were impressed at that time with the relative haziness of the clinical picture of secondary malignancy within the lungs. My series differs from Dr. Hall's in that we had only one case in which there was no history of blood-tinged sputum. Later we began to realize that there was a different type of secondary malignancy—the metastatic type in which we got the shower of malignant cells in the lungs. Our attention has been called to the fibrous type of metastasis. I have not been able, so far, to differentiate that from fibrosis produced by numerous other conditions.

In regard to the miliary type, I must say I find it very confusing at times to differentiate from tuberculosis.

Regarding mediastinal shadows, of course, one must rely largely on the fluoroscope to exclude aneurism. We must remember, however, that if the aneurism sack is filled with clotted blood, we will not get pulsation. We should look upon tumor masses extending from the mediastinum as probably malignant. Lymphosarcoma is the most common condition found. Primary carcinoma is the most confusing we have to deal with. When it occurs as a discrete area of increased density radiating from the hila, we can advance the opinion that it is primary malignancy. We used to think it more common in the lower lobes, but we now feel it can be found anywhere.

We have recently been confronted by a condition which is unique to me, i.e., yeast infection in the lung which simulates almost exactly our conception of what primary carcinoma should be.

Dr. Holmes' paper is a distinct contribution to literature. I have felt, personally, that there are cardiac conditions in which we meet with congestive conditions in the lung, either diffuse or localized, which are difficult to classify or diagnose.

Personally, in speaking of peribronchial tuberculosis, I think we do not make a diagnosis of peribronchial tuberculosis without consolidation in the periphery of the lung.

I was so glad to hear Dr. Holmes say that the pathologist at the Massachusetts General Hospital has put the brakes down on syphilis of the lung. I have been looking for one for twelve years.

I would ask Dr. Holmes if he found any cases of pneumofibrosis in exophthalmic goiter. We see shadows in the goiter which are difficult to explain. I would like to ask how many cases of tuberculosis he found in exophthalmic goiter.

Dr. Pirie. I would like to ask Dr. Holmes if he has really seen good clear lungs in chronic cases of heart disease.

Dr. Hickey. In cases where you have massive effusion on one side and where you suspect new growth of lung underneath effusion, if you draw off the fluid and pump the chest full of air, you will get a plate that will help you with diagnosis.

Dr. Holmes (closing discussion). In regard to the changes at the hila, I have noticed such conditions.

In treating a considerable number of goiter cases, we took plates of the chest as a routine procedure. At that time we were having considerable difficulty in differentiating the appearance from hilus tuberculosis. Since having the metabolism test, that thing has not come up.

In regard to Dr. Pirie's question, I find it rather difficult to answer. I have not gone through and studied carefully all the cardiac cases, but I can see where that would happen. A large percentage of cardiac cases are decompensated, and it is difficult to get a good plate of the cardiac region.

---

* Papers read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922. Those of Drs. Hall and Childs appeared in March, and the paper by Drs. Holmes and Dann precedes this discussion.

The next to the last case I presented shows, I think, that it clears up when the heart is doing the work it should. A man may have a definite cardiac lesion, not of long standing, and if not decompensated, there is no change in the lung.

A STUDY OF LOBAR PNEUMONIA AND ITS PULMONARY COMPLICATIONS BY SERIAL ROENTGENOGRAPHIC EXAMINATION*

BY L. R. SANTE, M.D.

Assistant Professor of Roentgenology, St. Louis University Medical School; Roentgenologist to St. Louis City Hospital; Consulting Roentgenologist Koch Hospital for Tuberculosis. From the Department of Roentgenology, City Hospital

ST. LOUIS, MISSOURI

Among 272 cases of frank lobar pneumonia treated at the St. Louis City Hospital during the past two years, 152 were subjected to roentgenographic examination. Roentgenograms were made at from one- to three-day intervals during the course of the disease, and the findings were carefully correlated with clinical history and physical signs in many of the cases. This study of lobar pneumonia was undertaken with a view of determining the natural course of the disease, its complications and its sequelae.

From the pathological viewpoint, four different stages of the pulmonary lesion are recognized in pneumonia: (1) The stage of congestion and engorgement; (2) the stage of red hepatization; (3) the stage of grey hepatization, and (4) the stage of resolution. The stage of congestion is characterized by the engorgement of the blood-vessels and lymphatics and the production of an active edema in the air spaces, and, to some extent, in the interstitial tissue. At autopsy, particles of such material, although considerably denser than normal, will still float on water, showing that they are still air-containing to some extent. The increase in density of this material would hardly be sufficient to cast as dense a shadow in the roentgenogram as that produced by the stages of red and grey hepatization. This stage is so transitory, however, often lasting but a few hours, and the difference in density of the shadow in the roentgenogram so slight, that it is quite obvious that any differentiation of the active stage of consolidation would usually be impossible from the roentgenogram. After the crisis has occurred, however, in the stage of resolution, the irregularly resolving and absorbing exudate produces an uneven mottled appearance in the roentgenogram, which is quite distinctive of this stage of the disease. Since, from a practical standpoint, it is, therefore, impossible to determine definitely the active stage of the disease from the character of the shadow, let us consider the distribution of the consolidation and its bearing on the course, diagnosis and prognosis of the disease.

Roentgenographic Characteristics. The pathologist tells us that the process of consolidation is closely confined to one or more lobes, so that a definite knowledge is necessary of the position which these lobes occupy and the location of their interlobar septa. To illustrate with more accuracy the location of the interlobar septa, this case has been introduced (Fig. 1). The inflammatory reaction incident to a pulmonary abscess in the hilus region has resulted in the pronounced thickening of all of the interlobar septa. This case represents, then, a much more practical demonstration than any which could be obtained in the autopsy room or by inspection of dissecting-room material, and is excellently adapted for a study of the interlobar septa and the position of the various lobes of the lung. From this roentgenogram, taken in the lateral position, it will be seen that the upper lobe makes up a much greater part of the lung tissue than is generally supposed. When the tube is centered at the 5th dorsal vertebra at 28 in. distance, it will be noted that the central ray falls very closely along the interlobar fissure of the upper and middle lobes (Fig. 2A), so that the resulting shadow of upper lobe consolidation should be clear-cut and sharply outlined at its lower border, and the entire shadow should be very dense. Any slight variation in centering or tube distance should make little difference in the resulting shadow. Whereas middle lobe involvement (Fig. 2B) should present a similar sharpness of outline at its upper boundary and a hazy outline for its lower border, the entire shadow should not be as dense as the shadow of upper-lobe consolidation. Where the lower lobe is involved (Fig. 2C), the extreme lower portion of the lung will also be involved, and the upper border of the shadow should be more or less hazy in the ordinary position of the *x*-ray tube. When these essential points are borne in mind, a lobar consolidation involving one or more lobes can be readily differentiated and the roentgenographic characteristics easily explained.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

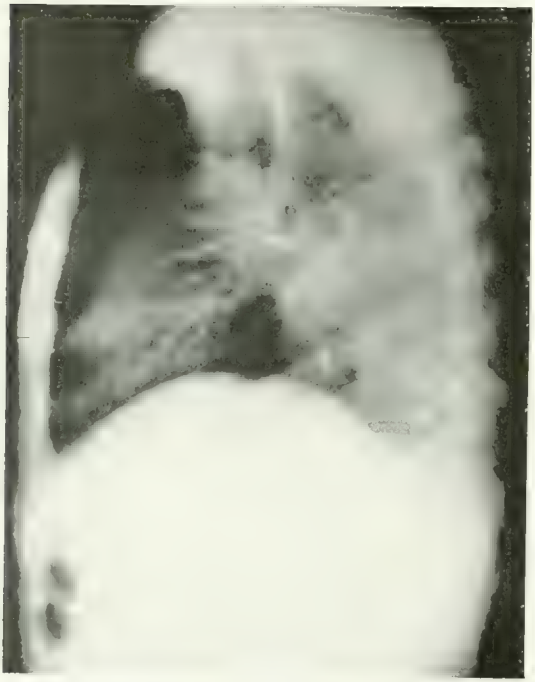


Fig. 1. Thickening of the interlobar pleura incident to a lung abscess in the hilus region. The marked thickening of the interlobar pleura serves to show the relationship of the various lobes. Note that the middle lobe does not touch the posterior chest wall at any point, but presents entirely at anterior wall.

Course of the Disease. Having analyzed the probable result of roentgenographic examination of consolidation of the various lobes, let us examine roentgenograms of various lobe consolidations, and pass to a consideration of the course of the disease. It will be seen that in practice the roentgenographic findings conform closely to those anticipated; atypical borders and anomalous lobes may occasionally be encountered (Fig. 3, A, B, C).

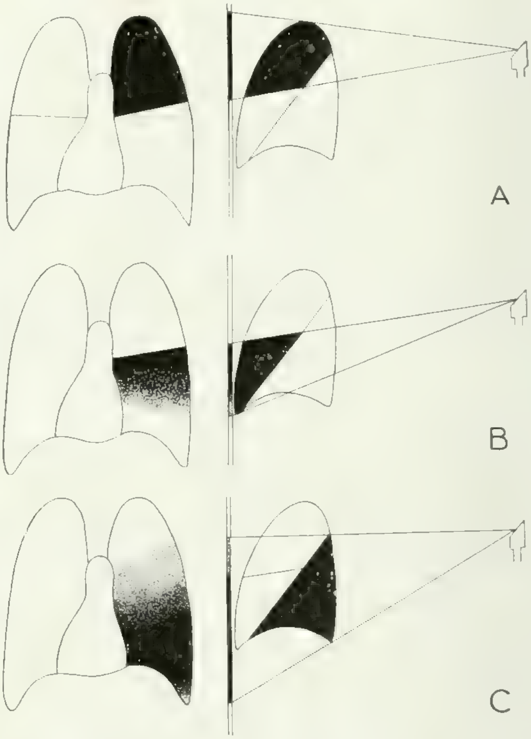


Fig. 2. Diagrams showing shadows produced by consolidation of various lobes, with the tube at 28 in. distance and centered at about the 5th dorsal vertebra. (A) Upper-lobe consolidation. The shadow is dense and the lower border is sharply defined. (B) Middle-lobe consolidation. In involvement of the middle lobe, the upper border of the consolidation is sharply defined, the lower portion is hazy. The extent of the shadow produced is relatively small compared to consolidation of other lobes. (C) Lower-lobe consolidation. The upper border of the shadow is hazy and the extent of the shadow produced is greater than any other lobe. The costophrenic angle often remains aerated during the acute stage of the disease.

In a great many of our cases there was complete consolidation of an entire lobe

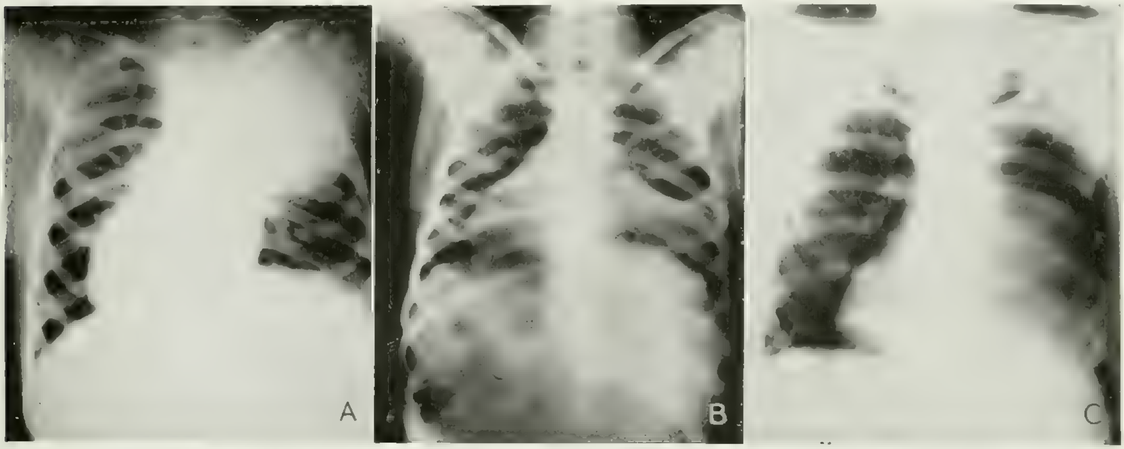


Fig. 3. (A) Upper-lobe consolidation. Note sharply defined lower border. (B) Middle-lobe consolidation. Note sharply defined upper border, hazy lower portion and small extent of involvement. (C) Lower-lobe consoldiation. Note hazy upper border, and large amount of involvement. Lower-lobe consolidation extends higher than middle-lobe consolidation. The costophrenic angle is aerated.

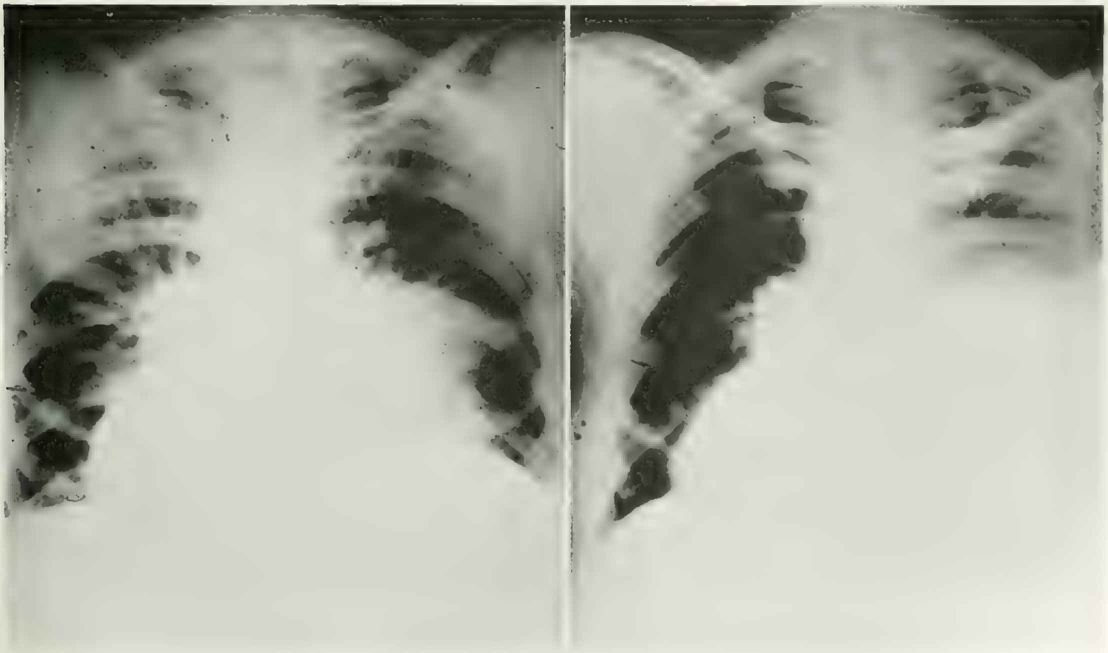


Fig. 4. Lobar pneumonia. (A) Consolidation commencing in the hilus region. (B) Plate made twenty-four hours later, showing extension to the periphery and involvement of the entire lower lobe.

at the first examination, even when the first roentgenogram was made within twenty-four to forty-eight hours after the onset. It is quite evident, therefore, that in many cases, probably the greater majority, complete consolidation occurs within a very short time. In a certain number of instances, however, the pathological process does not progress so rapidly. In some of these patients, on first examination, a definite consolidation was seen at the hilus region, which, on successive examinations, progressed rapidly outward, rarely requiring more than twenty-four to forty-eight hours to reach the periphery (Fig. 4). Whether of the slower, progressive type, or the rapidly consolidating form, the shadow produced is of a homogeneous character, presenting an even density throughout, showing only dense peribronchial markings, which, at the onset of the process, are usually seen through the consolidation shadow. The zone of advance of the process is feathery and uneven, and shades off into the normal tissue. The edge of the advancing shadow is composed of the radiating extension of accentuated peribronchial markings. This is probably due to the fact that the process, commencing in the hilus area, has progressed more fully to dense consolidation than that in the periphery, which is involved in the later stage, and also because the amount of consolidated tissue obstructing the ray is greater in the inner than in the outer zone of the lung. As the disease progresses, and consolidation becomes more dense, the peribronchial markings become obliterated, and the entire shadow may be of homogeneous density. In the natural course of the disease, little change is seen in the shadow from the time complete consolidation is reached until the time of the crisis. Shortly after the crisis, resolution begins, and the shadow changes rapidly from the homogeneous type to that of an uneven mottled appearance. Very soon the accentuated peribronchial markings again become apparent, and the uneven mottled area gives place to groups of soft isolated infiltrations. The entire area may be overshadowed by a pleural haze if the pleura has become thickened during the course of the disease. Resolution is very rapid, however, and all evidence of infiltration and consolidation may have completely disappeared within three days after the crisis (Fig. 5). Ordinarily, however, complete resolution requires a somewhat longer time—from seven to ten days; persistence of consolidation for fourteen days after the crisis should be viewed as distinctly pathological. It is, therefore, quite evident that the consolidation in lobar pneumonia, at least in many instances, starts at the hilus and extends peripherally.

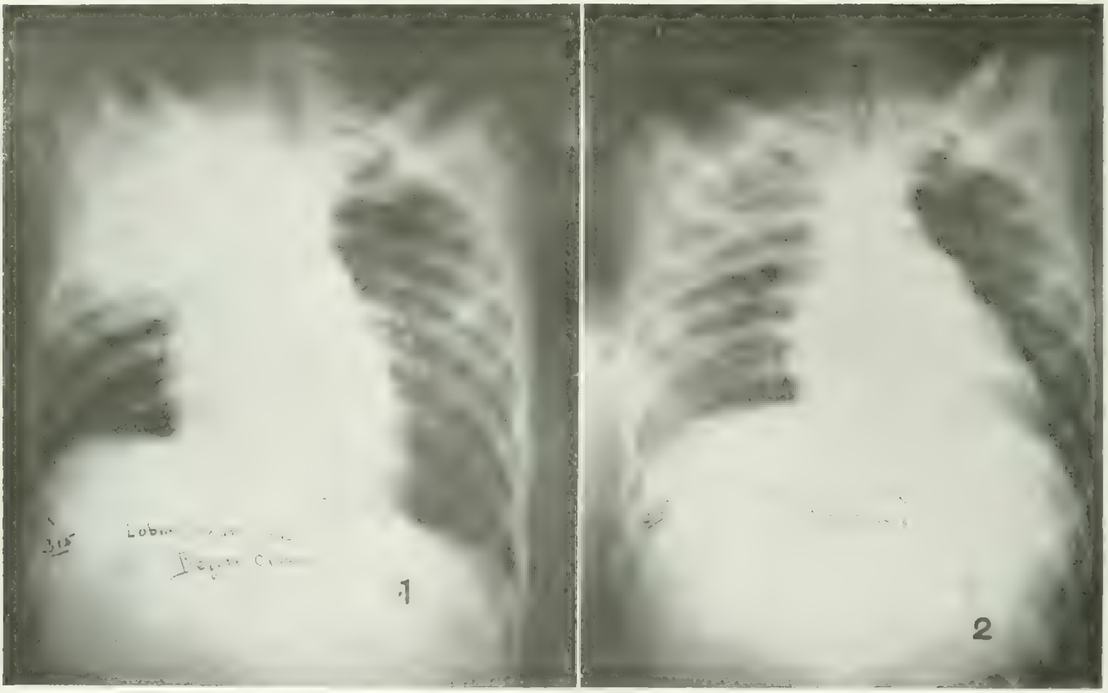


Fig. 5. (1) Upper right lobar pneumonia showing characteristic shadow. Plate made just before crisis. (2) Showing almost complete resolution in three days after crisis.

Review of Literature and Discussion. A review of literature, however, seems to show this at variance with the observations of some men. Mason[1] described the roentgenographic appearance of pneumonia in children as a triangular shadow with the base at the periphery and the apex at the hilus of the lung. He further stated that the consolidation commences in the periphery and gradually progresses to involve the hilus. He quotes the conclusion of Weill and Mouriquand[2] from the consideration of 350 pneumonia cases studied by *x*-rays, that the early shadow is usually triangular in shape, with its base usually conical and generally axillary. They have never seen a shadow which could be considered entirely central. Mason himself describes this consolidation and illustrates two cases, both of right upper-lobe involvement, which, in the roentgenograms, suggest a more intense consolidation at the periphery. He emphasizes the observation that the process of consolidation always begins in the part nearest the pleura and thus, during the beginning of the process, at any rate, is separated from the root of the lung by normal aerated lung tissue, and that central pneumonia, therefore, does not exist. On the basis of roentgenograms taken in cases in which physical signs of consolidation did not exist, where there was apparently an aerated zone of normal lung tissue beneath the surface consolidation, he concludes that in these instances the lack of physical signs is due to the failure of transmission of the breath sounds from the hilus through the aerated lung tissue to the surface. In December of the same year, Stewart,[3] in a publication on the differential diagnosis of lobar pneumonia and empyema in children, comments on Mason's theory as follows: "While I am not prepared at the present time to accept in its entirety the explanation given by Dr. Howard Mason of New York for the frequent lack of positive physical signs in some cases of pneumonia, I do believe that his theory holds good in many cases showing late physical signs. As many cases of pneumonia are believed to start at the root and spread toward the cortex, this explanation would seem to apply only to those commencing at the pleural surface." In the same publication he describes a root or hilus pneumonia in children, and shows illustrations of this type of consolidation beginning in the hilus region of the lung, spreading fanshaped into all the lobes and usually remaining confined to this region. In spite of this demonstration of root pneumonia, Barjon,[4] in his book on Pleuro-Pulmonary Affections, says: "These proofs do away with the idea of central pneumonia which would explain the late appearance of physical signs. Indeed, the shadow of the pneumonic triangle begins at this base, and this base is always cortical, since it develops in the axilla. Finally, the radioscope never shows in any case a primary central focus without some relation to the cortical portion of the lung. In short, central pneumonia does not exist, but everything progresses as if it did." In a recent publication the writer[5] reported 12 cases of hilus pneumonia occurring among 276 cases of pneumonia examined. Eleven of these were of the distinctly inflammatory type, 1 occurring in a child, and 10 in adults. In a previous publication,[6] the existence of hilus pneumonia in the adult in connection with the influenza epidemic was pointed out.

It is quite probable that many cases of pneumonia in children do follow the course indicated by Mason in his essay on pneumonia: beginning at the periphery and progressing inward to the hilus. Among the cases included in this series several instances are present where the consolidations occurring in children followed this course (Fig. 6). To say that this is the only course followed in children is manifestly wrong, in view of the many existing cases of hilus pneumonia previously cited in the literature. It is also unmistakably true that many cases do occur in adults in which the consolidation starts in the hilus region and spreads toward the periphery. While it is possible that in adults, certain cases may exist in which consolidation starts in the periphery, we have never encountered one in which this relationship could be established. Mason's explanation of the failure to elicit certain physical signs is probably quite correct in certain instances. It is also true that a similar obscurity in physical signs can occur when the consolidation is confined to the hilus region, in so-called hilus or root pneumonia, and it is

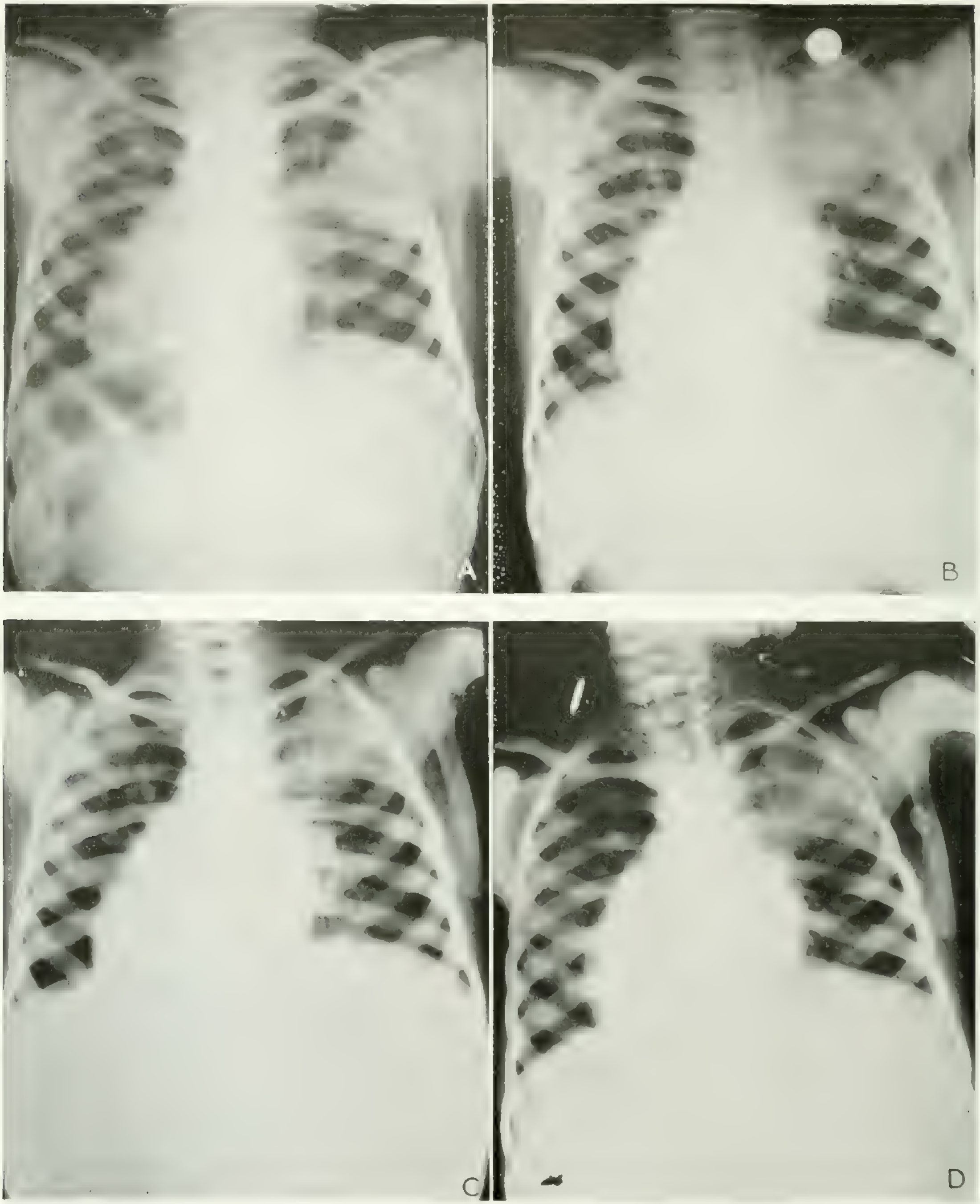


FIG. 6. Lobar pneumonia right upper lobe. Type referred to by Mason as starting in the periphery and advancing to hilus. (A) Note the consolidation of lower and outer portion of the right upper lobe. The sharply-defined lower border establishes the identity of the lesion as upper rather than middle lobe consolidation. (B) Within forty-eight hours there was advancement of the process to involve the entire upper lobe. (C) Shortly after the crisis resolution begins. (D) Continued favorable resolution of the process.

probable that the same explanation holds in these cases. Furthermore, from the plates which have been shown of lobar pneumonia in adults, it is evident that, in the greater number of instances, lobar pneumonia starts as a central consolidation in the hilus region and spreads peripherally. It would seem, therefore, that, at least in the majority of instances, our old conception of lobar pneumonia was the correct one; the obscurity in physical signs in certain instances being due to a centrally located consolidation which had not yet reached the surface.

Prognosis. Pneumonia, uncomplicated by other pulmonary lesions, may itself prove fatal. Neither the location of the consolidation, its extent nor the density of the consolidation is a determining sign in the prognosis. The most extensive involvement of lung tissue may end in recovery: the smallest areas of involvement may result fatally. The process in one lobe may resolve only to be followed by consolidation in another, possibly adjacent to the primary involved lobe, possibly remote. All the lung tissue on one side may be involved in a massive consolidation. As a general rule, however, involvement of a single lobe gives much the best prognosis, especially where the shadow shows the characteristic changes described as natural for the course of the disease. Usually, lobar pneumonia resolves very rapidly: three days after the crises may be sufficient for complete resolution; seven to ten days, however, is the average time. If fourteen days elapse after the crisis without signs of progressive favorable resolution, or if no crisis occurs within this period, the condition is abnormal, and it can be depended upon that some complication of pneumonia is present. Persistence of the shadow over this period did not occur in a single instance, unless there was some complicating pathology.

Pulmonary Complications. The most frequent pulmonary complications of lobar pneumonia are:

1. Dry pleurisy with thickening of pleura.
2. Pleural effusions, serous or purulent; either general or localized.
3. Plastic serofibrinous pleurisy.
4. Chronic interstitial pneumonia or fibrosis.
5. Lung abscess.

Dry pleurisy, resulting in a thickening of the pleura, both at the periphery and in the interlobe, is so frequent an attendant with pneumonia that it is probably best considered as a part of the pathological process. The presence of a pronounced pleural reaction is, in itself, almost pathognomonic of a recent inflammatory lesion. Roentgenographically, the linear shadow running upward along the parietal wall of the chest and the dense linear shadow extending across the chest from the hilus to the periphery when the interlobar pleura is involved, are familiar to all roentgenologists. After the disease has progressed to involve the pleura, a small amount of serous fluid may collect (Fig. 7). This obscures the costophrenic angle and produces a ribbon-like shadow along the parietal chest wall, not unlike pleural thickening, and at times almost indistinguishable from it. This occurs so frequently during the course of the disease that it

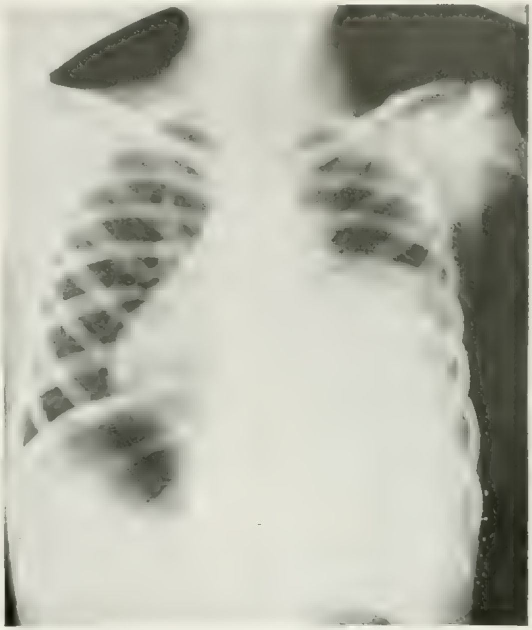


Fig. 7. Very frequently a small amount of fluid forms in the pleural cavity during the course of the disease. Note the ribbon-like shadow running along the parietal wall. The rounded appearance of the upper portion of the consolidated area is suggestive of a small collection of interlobar effusion.

seems quite probable that it is a provision of nature to keep the inflamed pleural surfaces apart, and prevent adhesions. Its presence is of little significance, merely adding to the difficulty of differential diagnosis between lower-lobe pneumonia and pleural effusion. Larger collections of fluid may occur in the free pleural cavity during the course of a pneumonia, and these have the same characteristics of fluid encountered under ordinary conditions in the chest. Where the pneumonic consolidation is in the upper portion of the chest, any additional shadow forming in the lower chest from the accumulation of fluid can be readily detected. The costophrenic angle, being the most dependent portion of the chest, is first to be obscured, and the shadow extends across the lower portion of the chest running up along the axillary border. The upper border of the effusion is hazy and concave, extending higher up toward the axillary side. The heart and mediastinal structures are usually displaced somewhat to the opposite side, due to the weight of the fluid. This is not an infallible sign, however, and has not been observed on certain occasions with moderately large effusions. Where a primary consolidation in the lower lobe is complicated by a pleural effusion, the diagnosis becomes more difficult, and it is often very hard to decide just how much of the shadow is due to consolidation and how much to fluid. Pleural effusions encountered as a complication of pneumonia may be either serous, serofibrinous or purulent. Since it is impossible to tell from the density of the shadow the character of the fluid, it is impossible to differentiate between serous effusion and empyema. The clinical picture may give some indication, but aspiration is the only reliable test. Pleural effusion may not only be general, involving the entire chest cavity as previously described, but may also be localized by adhesions between the two pleural layers at any point at which the pleural layers come in contact with each other (Fig. 8). This may be between lobes of the lung, when an interlobar effusion results. Such effusions usually present a clear-cut shadow extending across the entire half of the chest from the hilus to the periphery.

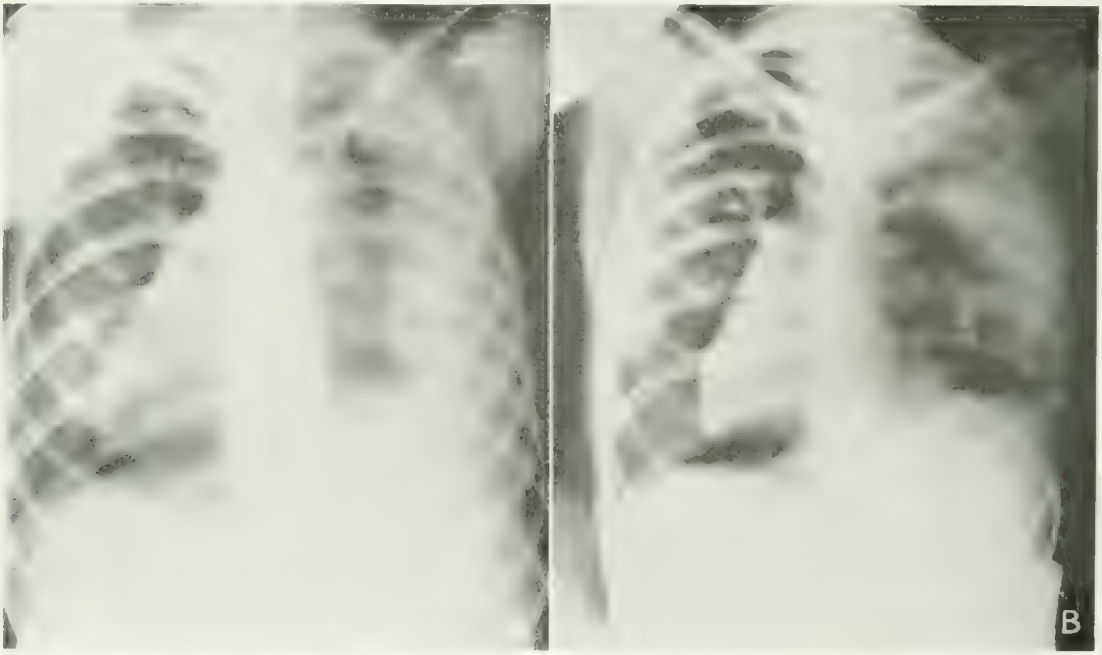


FIG. 8. Localized fluid entrapped between the two pleural layers. Localized collections of fluid, unassociated with plastic serofibrinous pleurisy, are sharply outlined. Being between the layers of pleura, the shadow is peripheral in location. (A) Localized fluid without pocketing. (B) Localized fluid showing a tendency to pocket formation.

The outer margin is often rounded and the lower border sharply defined, in these respects differing from consolidation of the middle lobe (Fig. 9). Collections of fluid, localized by adhesions of the parietal and visceral pleura, may occur in any portion of the pleural cavity. They are most frequent in the lower portion of the chest, in the axillary border and in the posterior cul-de-sac. Occasionally they are observed in the upper portion. Regardless of position, localized pleural effusions are nearly always sharply outlined unless they occur in connection with plastic serofibrinous pleurisy. In determining the location of such localized effusions, the lateral view is most helpful. Such effusions may be either serous or purulent in character. That small collections of pus, either in the lung or entrapped between the pleural layers, frequently escape detection, is evidenced by this case (Fig. 10, A, B, C, D). In this instance two drams of thick pus were aspirated from the lower chest during the height of the consolidation. Resolution progressed favorably and complete restoration to normal resulted. Pneumothorax is a very rare complication of pneumonia, and usually occurs in connection with post-pneumonic empyema.

Another condition which sometimes complicates pneumonia is plastic serofibrinous pleurisy. This complication, although not so frequently met with, is apt to be more serious than the other complications previously mentioned. Presenting no features akin to an effusion, it must necessarily be considered as a separate entity from the roentgenologic standpoint. The pneumonic process may run a natural course ending by crisis, the temperature may fall to normal and remain so for a short time, only to be followed by a post-critical rise and a persistent septic temperature, or a definite crisis may never occur, the temperature gradually assuming this septic character. Roentgenographically, the consolidated area does not resolve in the customary manner (Fig. 11). Large blotchy areas of increased density remain usually most pronounced at the periphery, the central portion of the shadow showing indication of normal resolution. The pleura is extremely thick and presents a stringy appearance, due to the fibrinous exudate. At autopsy the pleural surface is shaggy, with heavy strands of fibrinous exudate enmeshing small abscesses. These abscesses may attain considerable size, and may even represent localized areas of effusion. The pus content is usually very thick and creamy, due to the high fibrin content. The process may invade the lung, resulting in multiple small abscesses and interstitial fibrosis. Such involvement may be small in extent and may completely resolve, even where pus is present, leaving only a small pleural adhesion. Resolution of such a process usually requires six to eight weeks, however. Repeated roentgenographic examinations will indicate the progress of resolution, and will aid in determining the prognosis. Where the condition is very extensive, however, the outlook for ultimate complete restoration to normal is not so good. Where any considerable amount of pus is present, or where it is evident from repeated roentgenographic examinations that the condition is not progressing favorably, surgical intervention and evacuation of the pus may aid materially in the

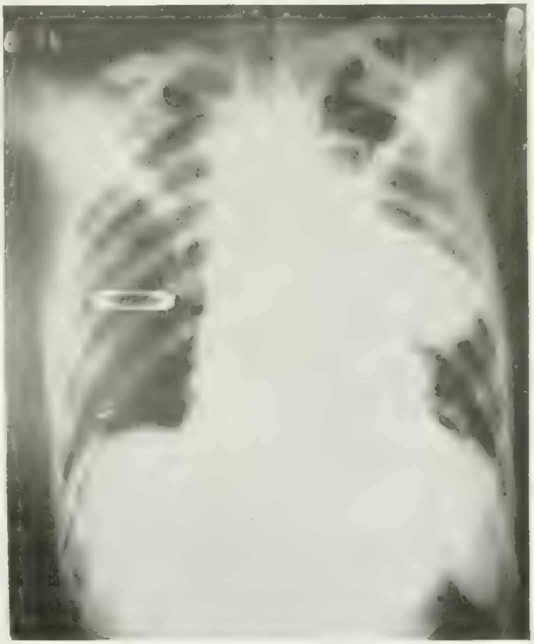


Fig. 9. Interlobar collection of fluid. Note the dense homogeneous shadow extending from the hilus to the periphery; note also the rounded appearance of the outer margin.

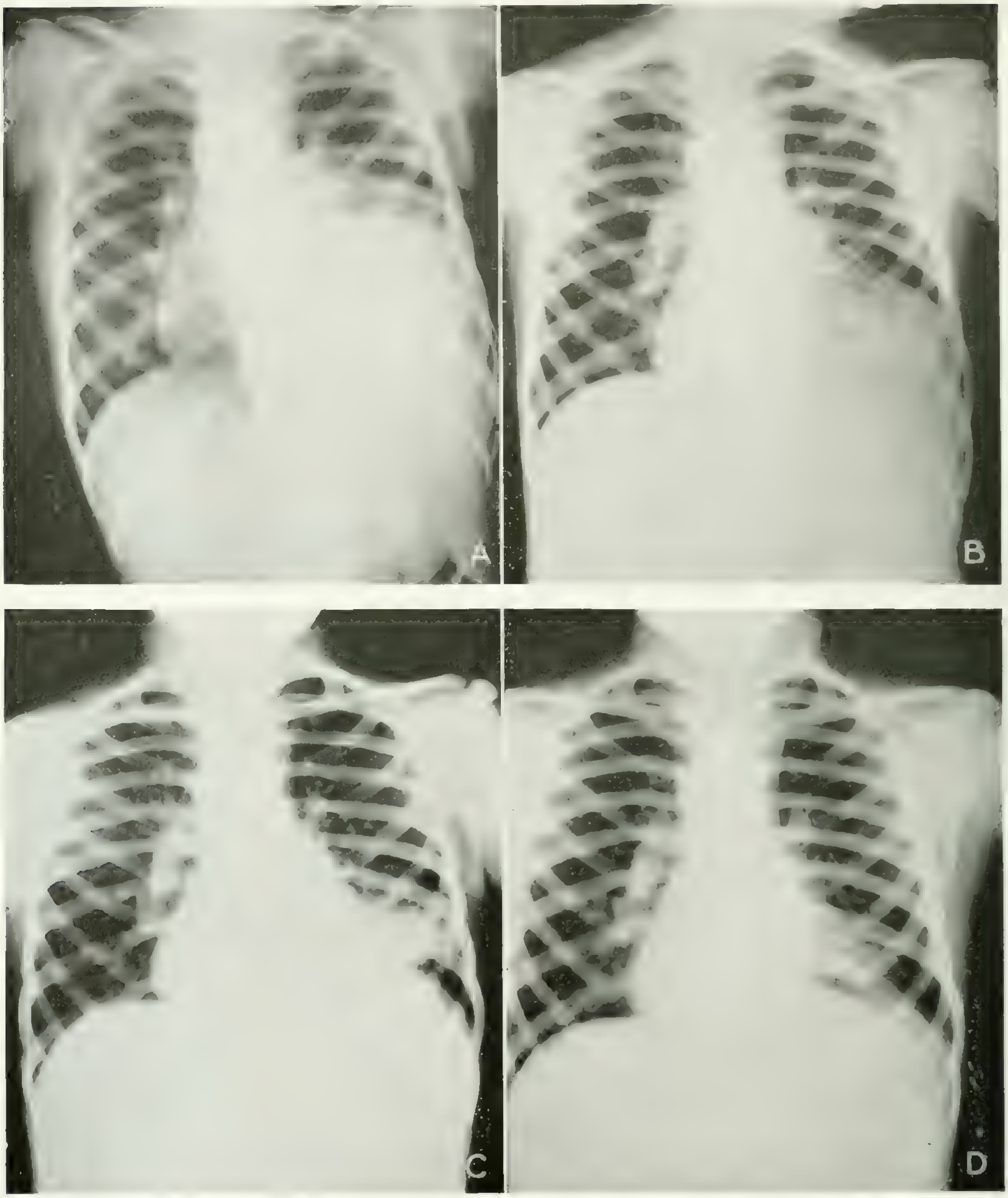


FIG. 10. That small collections of pus, either in the lung or entrapped between the layers of pleura, often escape detection, is evidenced by this case. (A) Lower right-lobe pneumonia just after crisis. At this time a needle was inserted and two drams of pus aspirated from somewhere within the involved area. (B) Plate made three days after aspiration of pus. Note the network appearance of upper border and marked recession of the process. (C) Plate made three weeks later, showing continued favorable but very slow resolution. (D) Plate two weeks later showing continued favorable resolution. Almost complete restoration to normal. Clinically the child had fully recovered.

ultimate recovery. By reason of the enmeshed character of the pus and its very viscid consistency, it often happens that surgical intervention or any other method of treatment is of little avail, and the process goes on to ultimate fibrosis (Fig. 12). The pleura, both parietal and visceral, becomes enormously thickened, obliterating the pleural cavity. The small abscesses entrapped between the layers of pleura throughout the fibrinous exudate become absorbed and are replaced by fibrous tissue. Organization takes place, and finally scar tissue is formed. The lung tissue may become involved and an interstitial fibrosis, similar in character, may result, either from an extension of the process, or as a result of functionless condition produced in the lung. The ultimate stage of the process is a contraction of the scar tissue. The heart and mediastinal structures are drawn over toward the affected side. The diaphragm is elevated and the intercostal spaces are narrowed. The entire side of the chest becomes more shallow than the normal side, a condition which is even more apparent since compensatory emphysema of the normal lung usually results. The entire lung is practically replaced by fibrous tissue showing a dense irregular shadow. The condition produced is known pathologically as chronic interstitial pneumonia. Some modification of this process is probably what has been referred to as "unresolved pneumonia."

The last complication of pneumonia to which I desire to call attention is lung abscess. Persistence of the consolidated area beyond the time normal for a lobar pneumonia, without favorable signs of resolution, is almost pathognomonic of abscess formation. Often, the diagnosis of a complicating abscess can be made by the roentgenographic appearance, fully five to seven days before the indications are present clinically.

Differential Diagnosis. During the early stage of lobar pneumonia, the consolidation may be confined to the hilus region and resemble, in all respects, hilus pneumonia. Within twenty-four hours, however, the hilus consolidation should spread toward

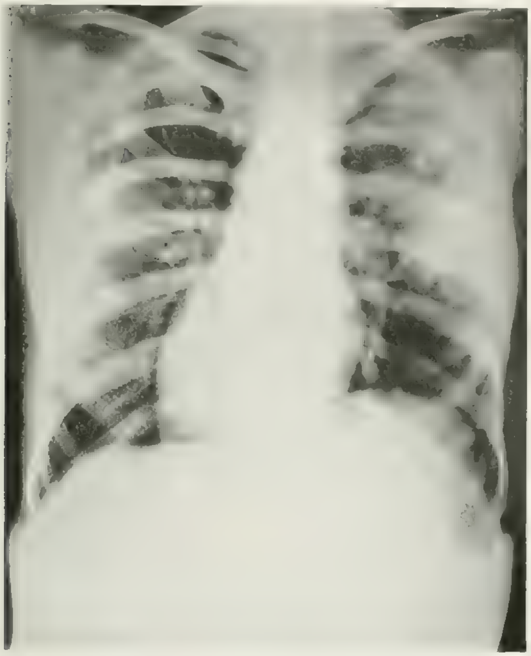


Fig. 11. Plastic serofibrinous pleurisy with localized collection of fluid. Note the peripheral location of the shadow, and that when associated with plastic pleurisy, localized collections of fluid are not sharply outlined.

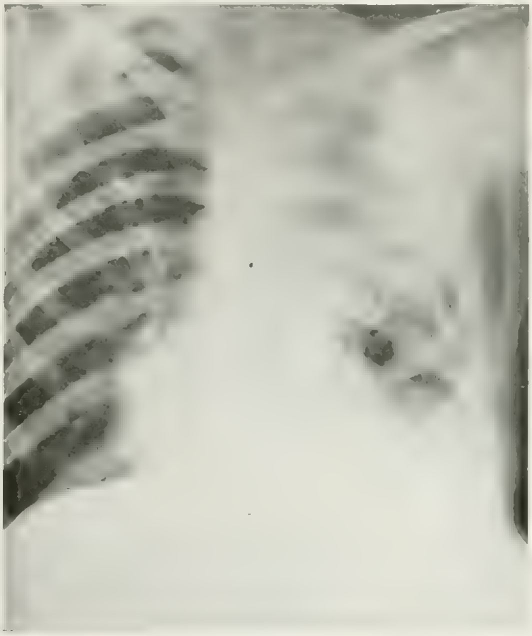


Fig. 12. Chronic interstitial pneumonia following organization of a plastic serofibrinous pleurisy. Note the narrowing of the interspaces, the elevation of the diaphragm and the displacement of the heart and mediastinal structures to the right.

the periphery, confining itself to a single lobe, if the condition is due to lobar pneumonia. If the condition is due to hilus pneumonia, the shadow will remain constant and will not spread peripherally. As a general rule, when the consolidation is fully developed, there is little difficulty in the diagnosis of lobar pneumonia. Occasionally, however, even the acute shadow of lobar consolidation may be confused with other conditions. Caseous tuberculous pneumonia (Fig. 14) may cause a massive homogeneous consolidation confined closely to one or more lobes, which may resemble in every detail the consolidation from lobar pneumonia. The symptoms and course of the disease readily differentiate the conditions. Caseous tuberculous pneumonia requires from three to four months for resolution, whereas lobar pneumonia may completely resolve in as many days. Caseous tuberculous pneumonia usually leaves behind definite cavity formation; lobar pneumonia resolves completely and leaves a perfectly normal appearance. It is undoubtedly true that caseous tuberculous pneumonia may occur in any of the lobes of the lung, but the upper lobes are undoubtedly the most frequent site; the right side being most frequently involved. Where the roentgenographic evidence alone is analyzed, the differential diagnosis may depend entirely upon the course of the disease. The clinical history, however, may serve at once as a determining factor. In the tuberculous type of pneumonic consolidation, the temperature is never so high and there are morning remissions even to normal, a condition not obtained in lobar pneumonia. There is not the pronounced leucocytosis obtained in lobar pneumonia. The patient does not feel exceptionally bad, and may even be up and about; in pneumonia, on the other hand, the patients are quite ill and confined to bed. In this connection may I say that in the opinion of the writer, positive diagnoses as to chest conditions without a previous consideration of the clinical history are very hazardous.

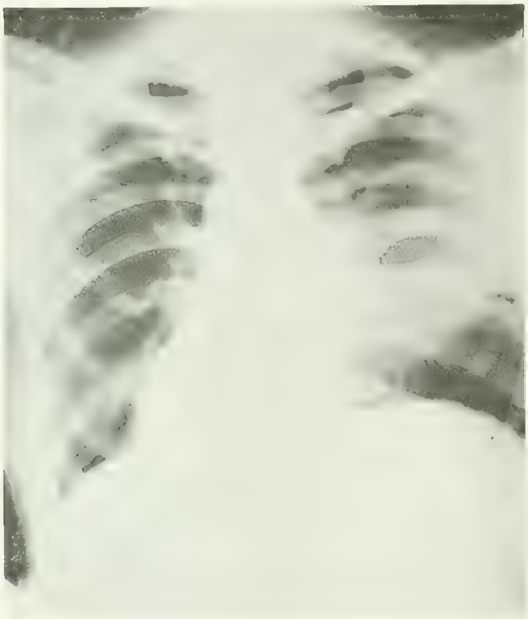


Fig. 13. Lung abscess following lobar pneumonia of the lower lobe.

Only under the rarest circumstances would the lobar distribution of a bronchopneumonia be confused with lobar pneumonia. The comparative rarity of the former condition, its occurrence in connection with septicemia or as a complication of influenza, its invasion by peribronchial infiltration and the blotchy, uneven appearance of the shadow will aid in the differential diagnosis of the two conditions.

Syphilis of the lung produces, at times, massive homogeneous consolidation, which may, at a single examination, resemble lobar pneumonia. While the consolidation from syphilis is usually more massive, a similar picture may be presented by lobar pneumonia, and again the determining factor must be sought in the clinical history. Whereas one would expect a patient with lobar pneumonia of this extent to be desperately ill, syphilis of this extent may have remarkably few symptoms. The Wassermann reaction and resolution of the consolidation after salvarsan are the deciding factors.

Tumors of the lung rarely produce any confusion. The only type of new growth which, in the writer's experience, has ever in any way simulated pneumonia, is the metastasis from a hypernephroma. Hypernephroma (Fig. 15) may be confined to the lower lobe of the lung producing a dense homogeneous consolidation which at times may simulate lobar pneumonia or fluid. Three such cases have come under the writer's observation, which were either confirmed by autopsy or microscopic sections from material obtained by lung puncture.

One of the most difficult differential diagnoses may be in the differentiation between lower-lobe pneumonia and fluid, or the simultaneous existence of both. The upper border of a pleural effusion extends from the hilus region upward and outward to the axilla, and may conform very closely to the upper border of a consolidation in the lower lobe. It is true that the costophrenic angle is obliterated in fluid and is usually well aerated during the acute stage of lower-lobe consolidation, but very often a somewhat later stage of the disease finds it obliterated, whether by extension of the consolidation to this remote portion of the lung, or by obliteration from a small collection of protective fluid, makes little difference in the difficulty of diagnosis. The heart and mediastinal structures are usually displaced in fluid, but, as has been said, that is not an infallible sign, for either no displacement at all may be present, or it may be so slight as to be indeterminate. Under certain conditions, therefore, the differential diagnosis between lower-lobe pneumonia and fluid becomes very difficult. A method which we have used occasionally, and have found most useful in the differentiation of the two conditions will be briefly outlined (Fig. 16). Since the upper bounding plane of the lower lobe is on a relatively straight line running from behind forward and downward, it follows that the image cast on a plate of consolidations of the lower lobe, if the ray is projected along the upper surface, will be a definite straight line, clear-cut at its margin and very dense. When made in the ordinary position, the beam of *x*-rays traverses the wedge-shaped upper portion of the lower lobe, causing a gradual shading off into the normal lung, and resulting in a hazy upper border which is not sharply outlined and not dense. Fluid, on the other hand,

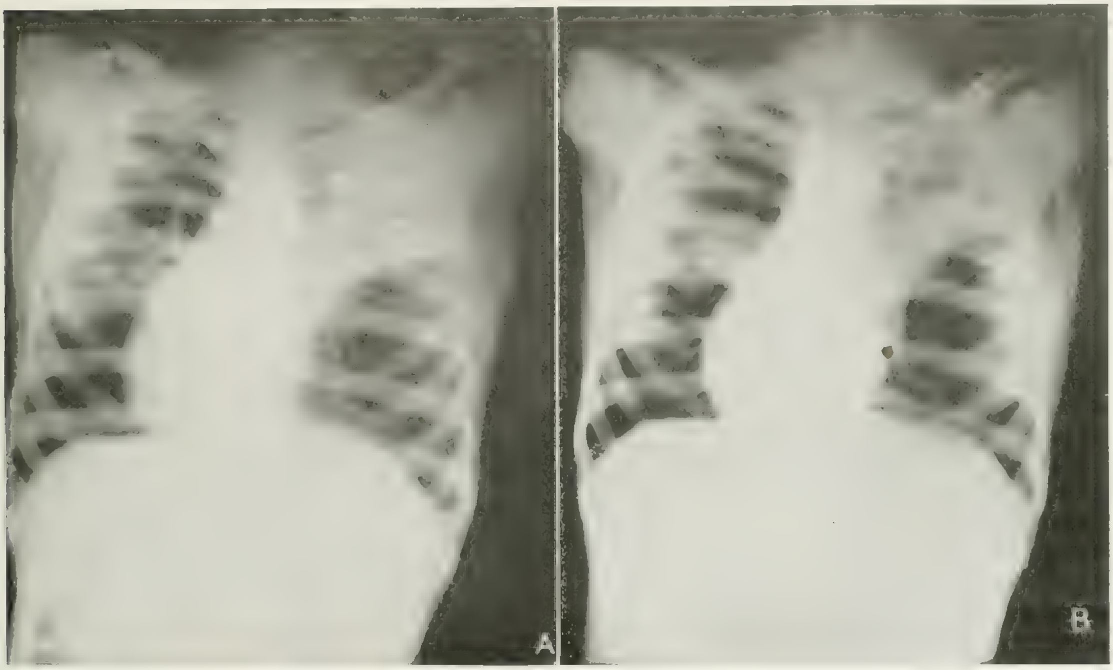


Fig. 14. (A) Acute caseous tuberculous pneumonia of the lobar type. This condition simulates very closely the consolidation from lobar pneumonia, and can only be differentiated at the onset by the lack of serious clinical symptoms, and later on by the protracted course of the disease. (B) Three months later. Same resolution has occurred with cavity formation.

when it has reached a stage confusing it with pneumonia, owing to the curved line which it produces, both from before backward and upward, and from within outward and upward, never casts a clear-cut upper border, no matter what the position of the tube. While roentgenograms made in the ordinary position may show a hazy, indefinite upper border, either in lower-lobe consolidation or in fluid, roentgenograms made with the tube centered high up will show a clear-cut upper border if the shadow is due to consolidation, but a persistently hazy outline if it be due to fluid.

In the resolving stage, the most easily confused lesion is that of the infiltrative type of tuberculosis. This is especially the case where the pneumonia involves the upper lobe. Here, again, the clinical history may be the determining factor: a short duration and profound illness suggest an inflammatory process; a longer duration without serious illness labels the condition as more probably of tuberculous origin.

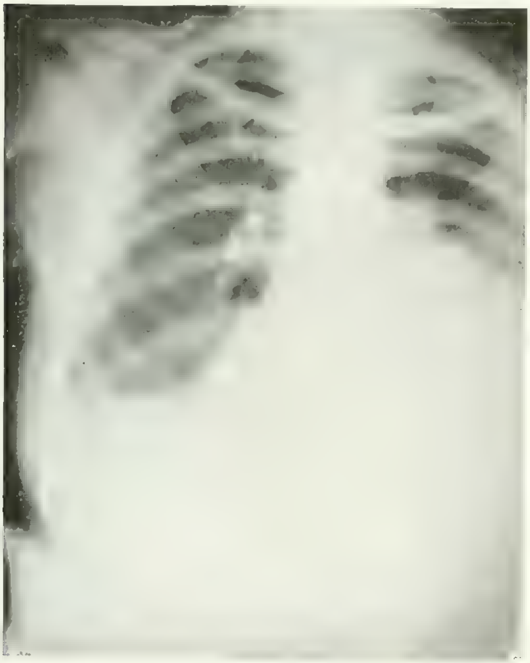


FIG. 15. Hypernephroma, metastatic in the chest, causing consolidation of the right lower portion of the chest simulating lobar pneumonia or fluid, and may be indistinguishable from these conditions without clinical history.

Localized pleural effusion will rarely be confused with tumors of the pleura, as the history and previous plates made during the course of the disease will differentiate. Localized pleural effusions are sharply outlined, and, being between the layers of the pleura, are seen at the periphery rather than at the midportion of the lung. In these respects they differ from lung abscess, which is not clearly outlined, being surrounded by an irregular zone of inflammatory infiltration; being in the lung substance, its shadow appears as a consolidation and usually does not extend to the periphery.

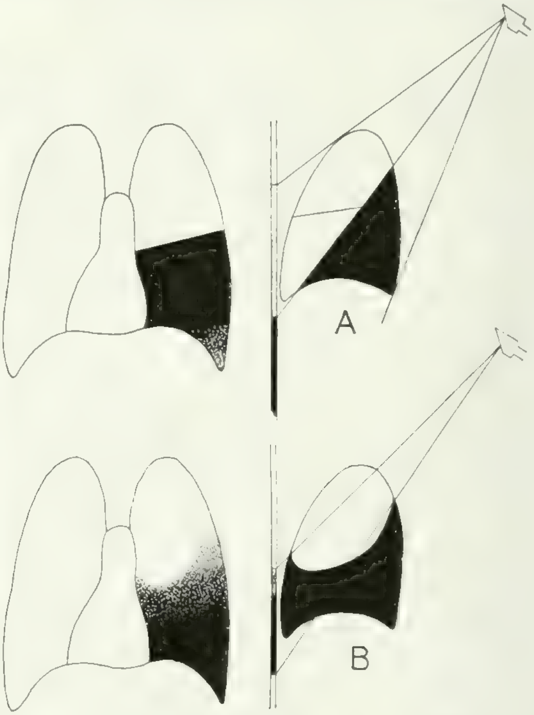


FIG. 16. Diagram showing character of shadows cast by lower-lobe consolidation and fluid with high position of tube. In this position the upper border of lower-lobe consolidation becomes sharply defined and the upper border of fluid remains hazy, no matter what the position of the tube.

Plastic pleurisy with localized collections of pus has the same peripheral location, differing thus from abscess of the lung, but is not sharply outlined and differs in this respect from an ordinary pleural collection.

The differentiation of organized pleurisy and interstitial pneumonia from large pleural effusions or massive pneumonic consolidations lies in the manifestations of scar-tissue contraction—the pulling over of the mediastinal structures, the pulling up of the diaphragm, the narrowing of the intercostal spaces and decrease in size of the pleural cavity on that side.

SUMMARY

1. Owing to the similarity in appearance, differentiation between the stages of active consolidation in lobar pneumonia is impossible from the roentgenogram.

2. In the majority of cases, lobar pneumonia starts as a consolidation in the hilus region, rapidly spreading peripherally, and involving an entire lobe. In a few cases in children, the onset of consolidation is cortical and progresses toward the hilus.

3. The shadow produced is homogeneous and is usually confined to one or more lobes. The shadow produced by involvement of the various lobes is indicated by diagrams.

4. During the stage of resolution the shadow becomes mottled and irregular, complete resolution being effected often in a very short time—three days.

5. The average time for resolution is seven to ten days after the crisis. Persistence of shadow or failure of resolution after fourteen days is distinctly pathological, and suggests some complicating lesion.

6. The pulmonary complications most frequently encountered following pneumonia are:

(*a*) Dry pleurisy with thickening of the pleura.

(*b*) Pleural effusion, either serous or purulent, and either general or local.

(*c*) Plastic serofibrinous pleurisy.

(*d*) Chronic interstitial pneumonia or fibrosis.

(*e*) Lung abscess.

7. Their roentgenographic differentiation is indicated.

BIBLIOGRAPHY

1. Mason, H. H. Lobar pneumonia in childhood. *Am. J. Dis. Child.*, March, 1916.
2. Weill and Mouriquand. *Am. de méd. et chir. inf.*, xvii, 275.
3. Stewart, Wm. H. Am. J. Roentgenol., December, 1916, p. 557.
4. Barjon, F. Radio-Diagnosis of Pleuro-Pulmonary Affections. New Haven, 1918, p. 103.
5. Sante, L. R. Study of hilus pneumonia by serial radiographic examination. *J. Rad.*, 1922, iii, 6.
6. Sante, L. R. Study of influenza pneumonia by serial radiographic examination. *J. Missouri M. Assn.*, February, 1921, xviii, 43.

DISCUSSION

Dr. Ullmann. Dr. Sante has covered the subject so thoroughly that I am rather at a loss what to say. At Santa Barbara we do not have very much pneumonia, although we have plenty of other things.

I would like to ask Dr. Sante if he has seen at any time what Dr. Billings spoke of in 1916 as pseudo-lobar pneumonia. I do not know whether there were any roentgen examinations made of these cases or not.

Dr. Sante did not speak of purulent bronchitis as a complication. I saw one child, twelve years old, who, after a pneumonia had cleared up, continued to run a temperature. The question of any empyema was seriously considered, although the physical signs were pretty well gone. Stereoscopic plates showed a cast of the entire bronchial tree which appeared as though it had been injected with an opaque medium. This condition entirely cleared up three or four days later.

I was glad to hear the statement made that any shadow remaining over two weeks was abnormal.

There was a condition seen during the war following gassing, especially after mustard gas, which I have never seen in civil life. I would like to ask if anyone else has seen it. During my service with the British Army I was fortunate enough to make stereoscopic plates of men dying with acute pneumonia following inhalation of mustard gas. These plates were made immediately after death and an autopsy held within a half-hour. I can best describe the appearance as a honeycomb. Bleeding into the pleural cavity was found at autopsy and the lungs were filled with patchy emphysematous areas in an edematous lung. These areas of emphysema and edema were apparently responsible for the honeycomb appearance in the roentgenograms. The hemorrhage and emphysema were probably due to the violent coughing which was such a marked feature of these cases.

I would like to ask Dr. Sante if there was any routine position for taking pneumonia cases. I take it that a portable outfit was used. I would like to know if he found it difficult to have the patients sit up for the examination.

Dr. LeWald. I was present at the time the paper referred to by Dr. Sante was read, and at that time made the statement that I had seen 2 cases of pneumonia starting at the root and extending to the periphery. This bears out what Dr. Sante has also observed, and I am sure that his observation is quite correct; that we do have pneumonia starting at the hilum and later extending out to the surface, although that may not be as common as pneumonia starting at the surface and extending to the root.

Dr. Sante (closing discussion). Referring to Dr. Ullman's statement as to psuedo-lobar pneumonia; one of the cases which I presented was such a case—so-called lobar distribution of brochopneumonia. Autopsy proved it to be bronchopneumonia following an influenza infection.

In the army service we were afforded opportunity to examine a great many influenza pneumonia cases at daily intervals, and were able to follow their development from clusters of peribronchial infiltration to the complete lobar lesion. Without serial radiographs the differentiation from lobar pneumonia would be very difficult.

I have had no personal experience with membranous bronchitis or recently gassed cases.

I was very glad indeed to hear of Dr. LeWald's observations and am quite sure that many here have had a similar experience. I feel, however, that the vast majority of lobar pneumonia cases start at the hilus and progress to the periphery. In a great number of instances this progress is very rapid, but many times a case will be encountered while the consolidation is still in the hilus region. In these patients serial radiographic examinations will show the progress of the lesion to the periphery.

PROGNOSIS IN TUBERCULOSIS OF THE LUNGS FROM EXAMINATION BY THE X-RAYS*

BY A. HOWARD PIRIE, M.D.

MONTREAL, CANADA

When a roentgenologist makes a diagnosis of pulmonary tuberculosis, it is seldom that he sees the patient after a lapse of six months, so that he can confirm his report. If he makes a mistake and gives a positive diagnosis and the patient is well after a year, no blame is attached to the roentgenologist and the physician in charge gets the credit of a cure. If, on the other hand, he makes a mistaken negative diagnosis and the patient goes from bad to worse, the patient naturally goes elsewhere for another *x*-ray report. It thus happens that our reports on pulmonary tuberculosis are not checked up as they are on fractures. We learn it very quickly if we make a mistaken diagnosis in stomach or bone work, but not if we give a mistaken diagnosis in a case of pulmonary tuberculosis.

In order to check up my own diagnoses of pulmonary tuberculosis I have analyzed my findings during three and a half years at a soldiers' hospital. This hospital has had the opportunity of following T. B. cases for three to four years, and during that time I examined 2,321 chest cases, making 2,574 stereoscopic plates. Of these, 141 were cases of T. B. of the lungs. Some of these cases reported once or twice a year for *x*-ray examination. All are now routinely examined by stereoscopic sets.

I selected the films of patients who had pulmonary tuberculosis and who were examined by *x*-rays year by year, and put these films up side by side. By this means I have been able to see the advance in the disease from year to year. From the excellent clinical notes which have been kept of these patients, I have confirmed the clinical findings with the *x*-ray plates and made a short summary to go with the plates. It is interesting to note that in general the *x*-ray findings of pulmonary tuberculous disease have been in advance of the clinical findings. I have also been struck by the fact that patients in whom the *x*-rays have shown no tuberculosis have been sent to a sanatorium and have returned after about a year with a report of disease arrested. In these cases, on comparing *x*-ray plates made before and after the sanatorium treatment, no trace of T. B. was seen at either examination. In such a case I have felt inclined to congratulate the patient on not contracting T. B. from his companions at the sanatorium. I consider that as to sending a patient suspected of tuberculosis to live in a sanatorium, to mix with undoubted cases (if no T. B. has been found in the sputum and the *x*-rays do not give a positive diagnosis of it) that patient would be better off and run less risk at home than in a sanatorium.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a later number of the Journal.

My earliest diagnoses of T. B. are given from stereöscopic plates showing mottled areas. Advanced cases are easily recognized, and cases which are so early as not to show mottling I do not diagnose as T. B. Simple intensification of the bronchial tree is certainly not an early sign of tuberculosis, but may be a result of former healed tuberculosis. It is very constantly present running up to the apices when the note at the apices is flattened. This, to my mind, does not indicate early T. B., for in none of my series extending over three and a half years has this simple intensification of the bronchial tree been followed by active T. B.

I shall detail one case to you, typical of others showing the *x*-ray diagnosis preceding the clinical to the extent of one year.

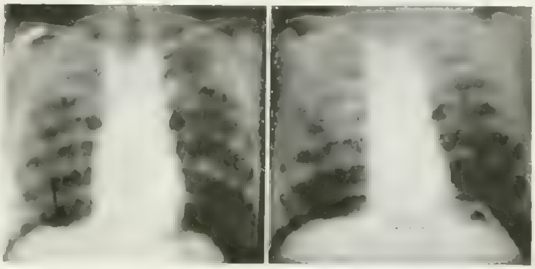
Case I. Male, complained four years ago of varicose veins and nothing else. No *x*-ray examination made. Three years ago he complained of a cough. The clinician reported no adventitious sounds, but impaired note at both apices. *X*-rays at this time showed T. B. at left apex and a localized pneumothorax.

The next examination reported was two years ago when the clinician stated that his general condition was good: rales at right apex; otherwise breath sounds normal (1921).

The next examination was six months ago, when he had cough and expectoration, breath sounds vesicular, and a few rales in both upper lobes. A week after this examination he reported spitting of blood.

From the clinical report from 1919 to date, I would not expect that *x*-rays made in 1920, 1921 and 1922 would show that the disease had progressed. The first *x*-ray examination made in 1920 showed a distinct circular shadow like a cavity which completely disappeared in the later examinations. This circle was a localized pneumothorax.

In watching series of *x*-rays, made at intervals of a year or more, of cases of T. B., it is interesting to note that as the disease advances the heart grows smaller. This smallness of the heart has given rise to the idea that a small heart is a characteristic of a tendency to tuberculosis. I have often been struck by the absence of T. B. in cases of very small heart. I believe a small heart is the result of advanced T. B., and not a predisposing cause of T. B.



Case II. Shows the increase of the disease and the diminution in the size of the heart over a period of two years.

Case II illustrates this. The *x*-ray examination made in 1920 showed a fair-sized heart, while the appearance as seen in 1922, when the disease had advanced, showed the heart much smaller. In 1918 this man weighed 135 lbs., and in 1922 he weighed 105 lbs.

Case III indicates the progress of the disease with *x*-rays made in 1919, 1920, 1921 and 1922. That in 1919 showed greater disease with small pneumothorax. The patient's weight was then 108. The pneumothorax continued for the next two years and cleared up in 1922, when his weight was 111 lbs., a gain of 3 lbs. The *x*-ray examination in 1922, however, showed the heart smaller than in 1919.

The clinical reports in 1918 state, "lungs negative," and again in 1919, "lungs negative." Not till 1921 did the clinician note the presence of crepitations. The last clinical note in 1922 stated that the patient was generally weak, thin and pale. These films illustrate a nonprogressive type of T. B. In 1919 he was an undoubted case of T. B. from *x*-ray examination, when the clinician reported no adventitious sounds present. It illustrates the appearance and disappearance of a small localized pneumothorax.

CASE IV shows the appearance of chronic T. B., with positive sputum without active disease. There is an interval of twelve and a half months between the two *x*-ray exposures, and during that time the patient gained six pounds in weight. The later plate shows increased calcification, but the heart has grown smaller. The decrease in the size of the heart is the worst feature in this case from the *x*-ray point of view. I would call this a slowly progressive chronic T. B.

CASE V. The *x*-ray report of T. B. preceded the clinical report. The two plates were made at an interval of thirteen and a half months. In the 1921 plate no T. B. was shown. In the 1922 plate the T. B. is evident; and the decrease in the size of the heart is very marked.

CASE VI is the type in which, from the *x*-ray appearance, a bad prognosis should be given. In 1919 he showed a pneumothorax at left apex with evidence of T. B. in right and left lung. The following year the pneumothorax had increased and the heart had grown much smaller. This decrease in the size of the heart is a bad sign. The plate made in 1922 showed the heart to be a little larger than in 1920. This may be due to dilating heart from impending failure, as death occurred ten days after this last plate was made.

CASE VII indicated extensive T. B., which, after fifteen months, showed marked improvement. The 1920 plate shows T. B. in middle of right lung and at right apex. The 1922 plate shows less evidence of disease about the middle of right lung. The evidence of improvement is enhanced by the fact that the heart has not grown smaller. The patient's weight is recorded at 120 lbs. in 1918, and the same in 1922. Here, then, is a man who has lost no weight, whose heart has not grown smaller, and whose T. B. has cleared up considerably as shown by *x*-rays. This case leads me to ask if T. B. growing from the hilus (as this case appears to be) is more liable to clear up than T. B. beginning in the upper third of the lung.

CASE VIII shows that the heart of a nonprogressive T. B. does not decrease in size. He had treatment for 326 days in a sanatorium during 1917–18. His weight was 120 lbs. in 1918 and the same in 1922. The appearance of the plate of 1920 is characteristic of nonprogressive T. B. Note once more that the heart did not decrease in size in this nonprogressive case of T. B.

CASE IX shows T. B. with very little if any advance, as shown by examination over a period of twenty months, with gain in weight during that period. Both plates show a fibroid condition at the right apex, but the most important point is that the heart has not decreased in size, but is actually a little bigger in 1922 than in 1920.

CASE X was diagnosed as T. B. by an experienced roentgenologist in 1919. I consider that he made a mistaken diagnosis, as after three years there is no evidence of T. B., though the root of each lung has that appearance which makes one hesitate whether to give a positive or a negative diagnosis of T. B. He was 4 lbs. heavier in 1922 than he was in 1919. This is a case of chronic bronchitis and not T. B. The size of the heart should be noted. It is as large in 1922 as it was in 1919. Had it been progressive T. B., the heart would have grown smaller.

RESUME

A. Favorable prognosis is based upon:
  1. Absence of abundant mottling.
  2. Presence of calcification in roots of lungs, and better still, in parenchyma of lungs.
  3. No diminution in size of heart.

B. Unfavorable prognosis is based upon:
  1. Abundant fluffy mottling.
  2. No calcification anywhere.
  3. Diminution in size of heart.

C. The diminution in size of heart with progress of the disease can be easily shown by *x*-rays. The diminution is out of proportion to the wasting of other muscles of the patient.

ENTEROLITHS*

BY W. W. BOARDMAN, M.D.

SAN FRANCISCO, CALIFORNIA

ENTEROLITHS are rarely recognized as the cause of occasional acute and chronic gastrointestinal disturbances, until so demonstrated at operation or necropsy. Indicative of their infrequency is the fact that in many of the standard works on gastrointestinal diseases, they receive no mention, and in others, but a brief note. Fitz and Williams report but three enteroliths in 713 cases of intestinal obstruction due to extraneous bodies, and Treves but 20 enteroliths in 1,152 cases of intestinal obstruction due to various causes.

Enteroliths are of three varieties. The first and most common are the hard enteroliths of relatively high specific gravity, usually dark brown in color, spheric or oval, generally smooth, single or multiple, averaging two to three cm. in diameter, but occasionally reaching 23 cm. Section is apt to show a concentric stratification about a central organic nucleus of chalk-like or dirty white layers, frequently alternating with others of a brownish color. The composition varies somewhat, but "usually consists of carbonates and phosphates, as the phosphate of calcium, the phosphate of magnesium and ammonio-magnesium phosphate. In addition, they usually contain organic substances, including a little cholestrin and occasionally other inorganic salts, as sulphate of calcium." Second, the less frequent soft enteroliths of low specific gravity and irregular outline which are composed of thickly interlaced masses of indigestible fibers and membranes, together with a small amount of other organic and inorganic material. This variety is relatively common in Scotland as the so-called oat stone or avenolith. Third, the very rare enteroliths that follow the prolonged administration of mineral drugs—calcium carbonate, magnesia, iron and salol.

Enteroliths may originate in any part of the bowel, but are generally stated to be more frequently found in the large bowel, especially in the cecum.

The mechansim of the origin and development of the hard enteroliths is not as yet clear, for although the bowel excretes inorganic salts, and under favorable conditions these may be deposited about some foreign body nucleus, there is no satisfactory explanation for the retention of this body until it has attained such size that its spontaneous evacuation is difficult or impossible. In response to the long-continued presence and gradual enlargement of the foreign body within the lumen of the bowel, there usually follows a more or less fusiform dilatation of the involved section of bowel, together with a definite hypertrophy of the wall. The enterolith lies quite free in the center of this dilated section, but meets with obstruction at either end.

Keeping in mind the very gradual development of these foreign bodies and the equally gradual compensatory changes occurring in the bowel, the resulting functional disturbances are readily understandable. For years, no appreciable clinical manifestations may appear. In time, however, symptoms arise and, as might be expected, constipation of some degree is the commonest. Associated symptoms are loss of appetite, nausea, belching, vomiting, flatulence, abdominal distress or attacks of abdominal pain, periodic attacks of diarrhea with or without evidence of inflammatory reaction, mucus, pus and blood. These symptoms vary in severity from time to time and are the symptoms of chronic low-grade intestinal obstruction. Rarely after years of such symptoms, there suddenly develops the typical picture of an acute intestinal obstruction, demanding prompt surgical intervention. More frequently, the process continues until death occurs from some intercurrent condition or until the clinical course becomes so distressing that surgery is resorted to, usually under a mistaken diagnosis and frequently with faulty surgical procedure, such as appendectomy, cholecystectomy, gastroenterostomy, etc.

Physical examination is apt to be entirely negative, but occasionally a tumor may be felt, hard, freely movable and, at times, tender. The commonest locations are the cecum, sigmoid and rectum.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept 12–16 1922.

The routine laboratory investigations render little or no assistance, and, as yet, *x*-ray studies have rarely been of aid in the pre-operative diagnosis. However, if the condition be kept in mind, careful radiologic studies should more frequently be successful.

From the reported cases it is evident that some enteroliths are not of sufficient density to be recognized in the plain abdominal roentgenogram. It is also probable that enteroliths of sufficient density to be so recognized are missed by not examining an abdominal roentgenogram obtained before the administration of barium, as especially with the double-meal technique, the barium in the small bowel may readily obscure an enterolith in the sigmoid or pelvic colon.

Fig. 1. Showing the shadow cast by the masses felt in L. L. Q. and in the pelvis.

With the routine barium meal, three direct findings may appear. First, a dilated and elongated section of the bowel; second, a filling defect resulting from the varying densities of the enterolith and the barium; third, if the meal be completely followed, an intensification of the shadow cast by the enterolith resulting from barium adhering to its surface. The barium enema should demonstrate more conclusively the dilatation and elongation of the involved section if in the colon; it should also show the filling defect and the intensification of the enterolith shadow after evacuation of the enema. Pfahler recommends the inflation of the colon with gas, but in his case it was of no assistance, and it seems probable that with a properly studied barium meal and enema, such a procedure would be superfluous.

Enteroliths in the small bowel will give less definite findings, the intensification of the enterolith shadow from adhering barium being the most likely. Careful study should discover some evidence of disturbed motor functions, such as have recently been emphasized by Mills.

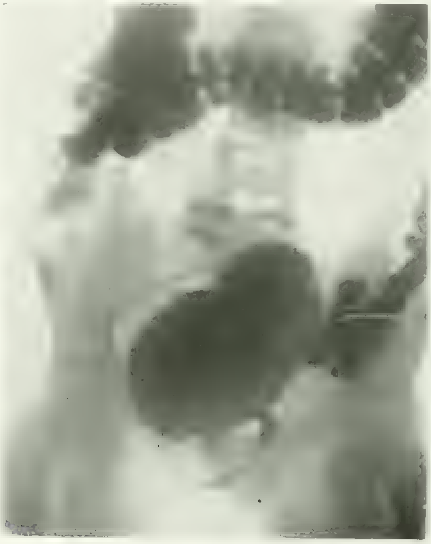


Fig. 2. Appearance after giving barium meal.

The enteroliths of sufficient density to be recognized on the abdominal roentgenogram can, by the above procedures, be definitely demonstrated within the intestinal lumen and thereby differentiated from calcified glands, kidney or ureteral stones, or other less dense bodies such as movable kidney, new growths, etc.

Differential diagnosis must be considered under three heads. First, in the relatively rare cases with acute intestinal obstruction, early surgical intervention will be of greater importance than the recognition of the exact etiological factor. Screen and plate studies of the abdomen before, during and after a barium enema would seem to promise well in suitable cases. Second, in the cases with chronic abdominal symptoms presenting either a palpable mass or an abnormal opacity on the plain abdominal roentgenogram, the barium meal and enema should show their position within the lumen of the bowel. They must then be differentiated from gall-stones, fecal masses and foreign bodies, if possible. Third, in the cases presenting chronic gastrointestinal symptoms, but without palpable mass or evident abnormal opacities on abdominal plates, we must rely on a carefully executed barium study to demonstrate the enterolith and to differentiate it from the various other causes for such chronic symptoms. The difficulties here will frequently be multiplied by previous operative procedures, gastroenterostomies, etc., which tend to center the attention on one part of the gastrointestinal tract.

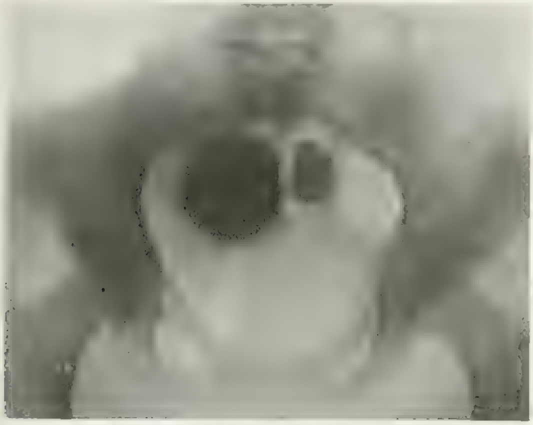


FIG. 3. Appearance after catharsis and colon irrigations.

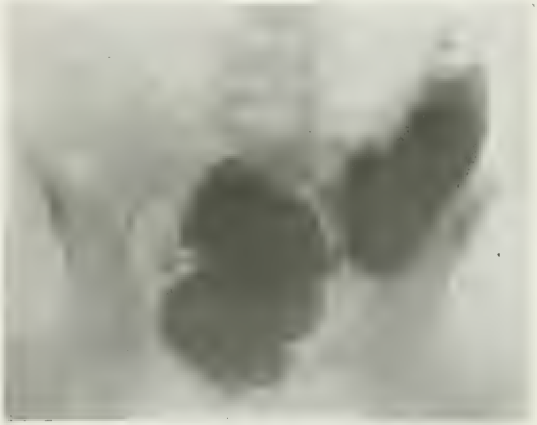


FIG. 4. After barium enema.

The following case report is typical:

Female, graduate nurse, aged twenty-seven. Came on January 14, 1921, complaining of pain in the epigastrium felt through to the back, acid regurgitation, sudden explosive and profuse vomiting without nausea, belching, loss of appetite, diffuse abdominal distention, marked borborygmus, marked flatulence, constipation alternating with diarrhea, and loss of weight.

Family History. Unimportant.

Past History. General health never good. Usual diseases of childhood. No recent acute diseases, other than a streptococcus sore throat in 1912. Respiratory, circulatory, cutaneous, nervous and urinary systems negative. Menstrual history irregular, but otherwise unimportant.

Gastrointestinal system. Had always had trouble, which began in infancy, with constipation, vomiting and colic, although she was breast-fed. During her early childhood days, constipation was her constant complaint, in spite of persistent treatment. At the age of seven she was having practically constant trouble with constipation, distention, distress after small amounts of food, belching, regurgitation and vomiting, marked and embarrassing borborygmus. She was underweight and undersized and lost a great deal of time from school. During her high-school period, she would regurgitate her lunch practically every day on the way back to school. She also had attacks of marked abdominal distention with crampy pains, relieved by the passage of large quantities of flatus followed by profuse and explosive diarrheal movement. Following such an attack, she would be relatively free from distention and abdominal distress for several days. Her condition continued practically unchanged until April, 1912, when an appendectomy was performed, at which time, a right-sided ovarian cyst as large as an orange was said to have been felt. Following the operation, there was some amelioration of symptoms, but no real relief. By March, 1913, all the old symptoms were back with increased severity. At this time it was customary for her to take soda six or more times at night and eventually get relief by vomiting. In the middle of 1914, the symptoms were extremely troublesome (she lost 40 lbs. in six weeks) and finally after failing to get relief with ulcer diet and hospital attention, a posterior gastroenterostomy was done with the Murphy button. This was passed forty-nine days later.

Following the operation, she was quite comfortable for six months, when symptoms reappeared with less severity; her principal complaints at this time being constipation with flatulence, distention, regurgitation and attacks of imperative diarrhea. During this period she was very careful about her diet, more especially in regard to the quantity. In 1917, she began her nurse's training and was able to complete it without loss of time, although never free from gastrointestinal distress.

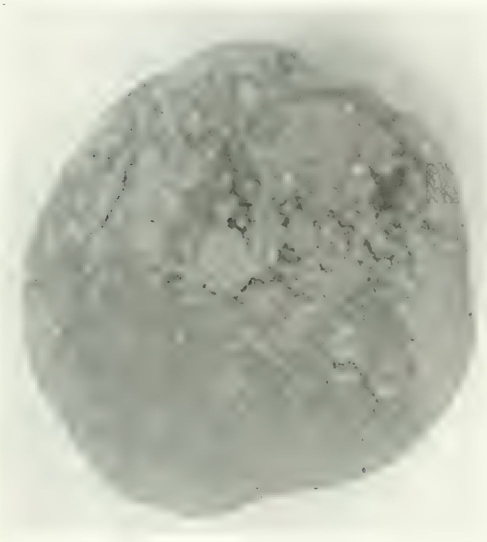


Fig. 5. Photograph of enterolith.

In October, 1920, after six months of private night duty, all her old symptoms reappeared, epigastric sensitiveness felt through to the back, recurring attacks of colicky abdominal pain, belching, acid regurgitation, explosive vomiting, distention, increasing constipation followed by colicky attacks in which she passed large quantities of intestinal gas, followed by several imperative liquid stools. After such an attack, there was always a short period of relief.

In December, 1920, she was placed on ulcer diet with Sippy powders, after a barium meal study, which showed a functioning gastroenterostomy and an apparent cap deformity with tenderness, presumably the evidence of a duodenal ulcer. No improvement resulting, patient entered Stanford Hospital on Jan. 14, 1921, for more thorough study and treatment.

Examination at this time was negative except for diffuse abdominal tenderness, hyperchlorhydria and hypersecretion. A second *x*-ray study showed an apparently normal outline for stomach and cap, except for the gastroenterostomy. At six hours, there was a very small amount of barium remaining in the antrum and cap. Head of the meal was in the ascending colon. Ileum and cecum appeared normal. At twenty-four hours, barium was scattered through the colon. The splenic flexure was high and filled with gas.

The history and findings failing to confirm a diagnosis of ulcer, ulcer treatment was discontinued and patient was put on a bland diet—sedatives, gastric lavage, etc. A diarrhea having appeared, patient was given liberal doses of bismuth subcarbonate over several days.

All therapeutic efforts were proving of no avail, when, on Feb. 5th, the patient noticed a hard, freely movable tumor about the size of an orange in the lower left quadrant of the abdomen, very slightly tender to pressure.

Pelvic examination revealed a large hard mass lying behind the uterus and not directly connected with the mass felt in the lower left quadrant. *X*-ray examination showed two masses of slight density corresponding to the above. Barium meal markedly increased the density of these shadows and demonstrated them to be in the lower sigmoid and pelvic colon.

It was therefore, concluded that we were dealing with a fecal accumulation in the pelvic colon and sigmoid. Thorough catharsis and repeated daily colonic irrigations brought away large amounts of granular material, so that after about ten days, the lower pelvic mass had disappeared and the upper mass was considerably smaller and freely movable. Nevertheless, symptoms persisted and on discontinuing the colonic irrigations there was evidence of re-accumulation of the material in the sigmoid and pelvic colon.

Further *x*-ray study was undertaken on Feb. 15, 1921, and demonstrated a round dense shadow about 8 cm. in diameter corresponding to the tumor mass felt. Barium enema entered readily to the middle of the sigmoid, where it surrounded the mass; this portion of the sigmoid was dilated. Descending colon apparently normal.

On Feb. 21, 1921, the abdomen was opened by Dr. F. J. Cowan through a lower mid-line incision. The pelvic organs were found normal. Within the lumen of the sigmoid there was a large hard, round, mass which could be displaced freely upward to a point about two inches from the junction of the sigmoid and descending colon and downward to within about the same distance from the rectosigmoid junction. There was a fusiform dilatation of the sigmoid, its largest central portion being about three times the normal diameter, and the walls hypertrophied. When the enterolith dropped down into the dilated curve of the sigmoid, it could be seen to exert definite traction on the rectosigmoid junction. The mechanism of the obstruction could be easily determined. The enterolith acted as a ball valve and as it was carried toward the rectosigmoid junction, it occluded the lumen of the bowel and the obstructive symptoms appeared. When it dropped back into the dilated curve of the sigmoid, relief came with the expulsion of gas and fecal matter. As the concretion could not be displaced downward into the rectum, it was removed through a transverse incision in the upper portion of the sigmoid opposite the mesosigmoid.

Postoperative course was uneventful; practically all symptoms disappeared, and at present, patient states that she has regular spontaneous bowel movements, no diarrhea, no distention, no regurgitation and no vomiting, has gained 20 lbs. in weight, and eats a regular diet, but finds that relatively small amounts satisfy her.

The enterolith was nearly spheroid in shape, of stony hardness, its surface smooth, and it measured 3 by 2¾ in. and weighed 45 gr. The sawed surface was equally dense throughout, its central portion was of a dark greenish color, while the periphery was laminated with alternate layers of dark green and dirty grey material.

Chemical analysis. By F. A. Cajori of the Department of Chemistry, Stanford University:

	Per Cent
Fat and free fatty acids less than	1.0
Cholesterol	0.8
Fatty acids from soaps	16.8
Calculated as calcium stearate	17.9
Ash	36.3

Analysis of Ash:

CaO	12.3
MgO	15.5
P_2O_5	8.5

CONCLUSION

1. Enteroliths, although rare, must be kept in mind in all chronic gastrointestinal cases.
2. Keeping them in mind, correct preoperative diagnosis is possible by careful physical and *x*-ray studies.
3. In all operations upon obscure gastrointestinal cases, a thorough exploration should precede operative measures.

ROENTGEN THERAPY OF ACUTE INFECTIONS OF THE ANTRUM AND FRONTAL SINUS*

BY JOHN D. OSMOND, M.D.

CLEVELAND, OHIO

THIS paper is intended as a preliminary report of results obtained from the treatment with the *x*-ray of twelve cases of acute inflammation of the frontal sinus and antrum. Ten of the cases were in the acute purulent stage, three of which were bordering on the chronic stage. Two were in the acute catarrhal stage.

The attention of the writer was called to this subject when patients were relieved from pain in the forehead for a time after the making of radiograms for the diagnosis of a suspected frontal sinusitis.

The first treatment was given in 1916 in a case of frontal sinusitis that was steadily getting worse under the usual treatment given by the rhinologist. The anterior end of the middle turbinate had been removed and good drainage obtained. For ten days the patient complained of more pain each time she came to the office and there was no cessation of the drainage of pus. At this stage a two-minute treatment was given directly over the frontal sinus using 6½-in. spark-gap, 5 ma., 3 mm. of aluminum and 8-in. distance. For twelve hours the pain increased, and the following day the drainage tract was sponged out with adrenalin and cocain. The second day the discharge was less and the pain had disappeared. A day later another *x*-ray treatment was given for a minute and within the next five days all discharge stopped and has never returned. Up to this time the patient has had no further sinusitis. A re-examination in 1919, and another in July, 1922, show a greatly increased density of the sinus in question.

This permanent change will be discussed while considering the pathology of the condition.

Cases number X and XI will be given at this time, and short reports of the remaining cases with the lantern slides. These two cases appear to border on the chronic stage of sinusitis.

Case number X is an attorney. In January this year he had the flu. A persistent nasal discharge kept up until April when he consulted a nose and throat specialist. The intranasal examination revealed an infected left antrum, which was punctured and irrigated. During April, May and June the antrum was irrigated 25 times. On July 1st his physician went on a vacation. On July 5th the patient came to our office for examination and advice because of great pain and discomfort. The *x*-ray films revealed both frontals involved as well as the left antrum. He was given a two-minute treatment through the frontals from the left lateral position and the same treatment through the left antrum. Two days later he declared that all his discomfort and confusion had stopped within a half-hour after the treatment. The second treatment was then given directly over the anterior surface of the sinuses involved. Within a week all discharge had stopped and the patient said he felt better than at any time for six months, which dated back to the flu infection in January. He has continued to improve and up to this time has shown no further signs of sinusitis.

Case number XI is a manufacturer, aged 59. He has had for two years a constant watery discharge from the nose accompanied by frequent sneezing, due to an irritating dust in his manufacturing plant. He would require a dozen handkerchiefs during the day and nearly as many at night. In January, 1922, the discharge became yellow, and by April he began to have pain over the right eye and in the right antrum. He then went to a nose and throat specialist and only the antrum was treated. It was punctured and irrigated eight times during a period of five weeks, with no improvement. On July 11th he came in for examination. The *x*-ray films showed a marked cloudiness of the right antrum and right frontal sinus. An *x*-ray treatment was given the same day and again in two days. He has required seven *x*-ray treatments and no further irrigations to clear up his symptoms. Estivin was used to help check the profuse secretions, which would begin as soon as he would read for a few minutes.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

Now let us consider the etiology of acute purulent sinusitis. According to Ballenger, Phillips and Skillern, infection of the antrum may be due to:

1. Direct extension from the nasal mucosa, as in coryza.

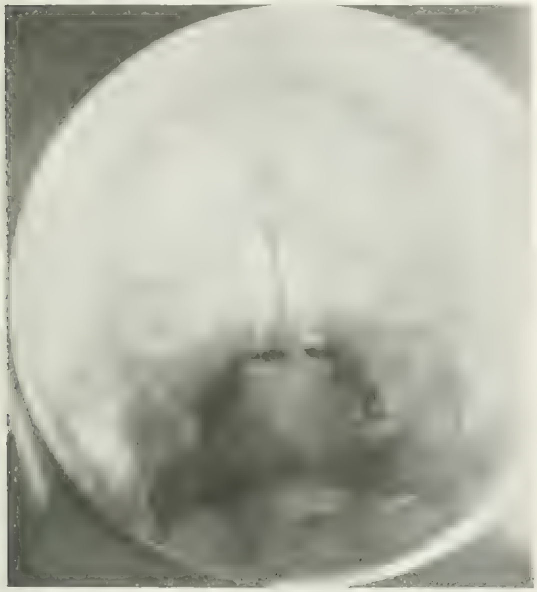


Fig. 1. Case I. July 31, 1922. Right frontal sinusitis.

2. Infectious diseases, particularly influenza.
3. From the alveolus. About 20 per cent of the cases of maxillary sinusitis are thought to originate from an infected tooth.
4. Through contamination from an overlying sinus, such as the frontal or anterior ethmoid cells.
5. Foreign bodies.
6. Traumatism.
7. Osteomyelitis, syphilis, tuberculosis and malignant tumors. All the cases in this series come under the first two headings, namely, coryza or influenza, which are the most frequent causes of sinusitis.

Infection of the frontal sinus occurs much the same as infection of the antrum, with two exceptions, namely, the contaminated overlying sinus, and the infected alveolus.

PATHOLOGY

"The first pathological changes that occur in acute purulent sinusitis are chiefly confined to the lining mucosa which becomes inflamed, swollen and edematous. In other words, only the superficial layers of the mucosa are involved in the acute purulent condition, while in the chronic disease all the layers of the mucosa undergo pathological changes. Serum and leucocytes escape through the epithelial covering of the mucosa, where they mix with bacteria, epithelial debris and mucus. The secretions, at first thin and watery, become thick and tenacious and as the purulent stage progresses the leucocytes are thrown out in immense numbers. Unless the process is speedily arrested the tissue changes become permanent and a chronic sinusitis is established."

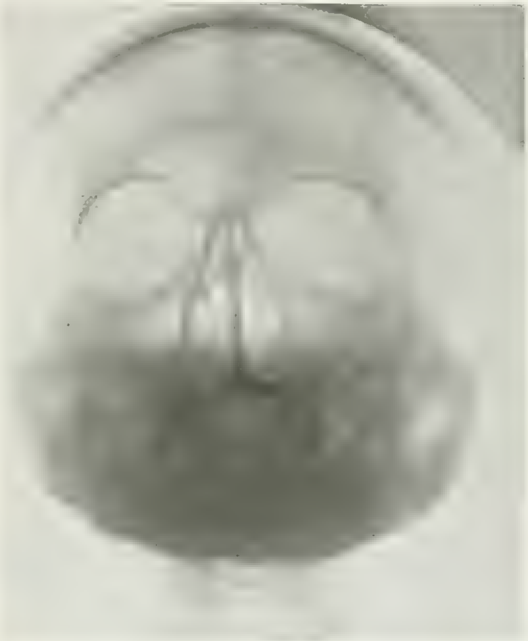


Fig. 2. Case I. Aug. 23, 1916. Right frontal sinusitis.

So much for the etiology and pathology. The question remains: What occurred when the *x*-ray was applied to the cases of purulent sinusitis to cause a complete cessation of all the symptoms and drainage of pus within three days to three weeks, where with drainage and irrigation no improvement had taken place in one to three months?

Perhaps it is too early to say that the application of the *x*-ray cured the sinusitis. At least it seems fair to state that the application of the *x*-ray was coincident with the relief of the symptoms and the cessation of pus in all the cases. One case has remained well for six years. The other cases are well at this time and their condition will be examined from time to time and reported later.

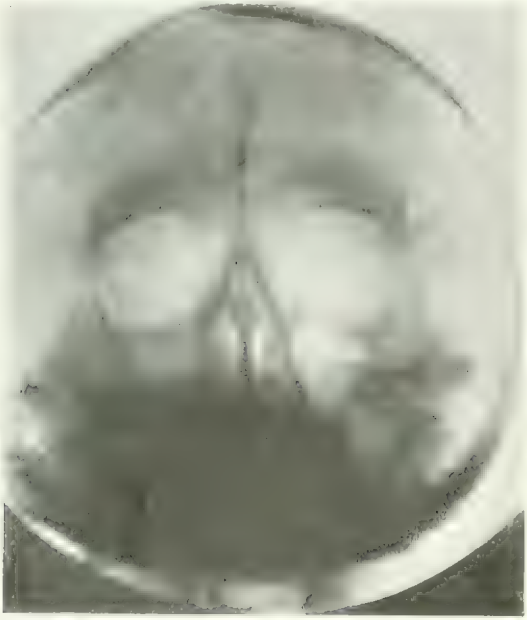


Fig. 3. Case X. July 5, 1922. Both frontals and antrum.

The thought of the writer is that rapid or forced resolution of the inflammatory process takes place; the leucocytes no longer escape and even the secretion of mucus ceases for a time. The mucosa, however, does not return to normal, but remains thickened, as evidenced by Case I, where the cloudiness has remained for six years after the cure of the sinusitis.

Chronic suppurative sinusitis with granulations, polypi or necrosis of the bone is the end result of the acute condition which every method of treatment seeks to avoid. The *x*-ray offers a method of preventing the acute catarrhal condition from becoming purulent and the acute purulent sinusitis from becoming chronic.

Two warnings must be given in the application of the *x*-ray to a purulent sinusitis. First, the eyes must be protected from the ray, or dimness of vision may result. Second, the chronic condition should not be treated with the *x*-ray, for no result can be expected where polypi have formed or necrosis of bone is present. Again, if there is pent-up pus, septicemia may result.

CASE REPORTS

Case II. Male. Jan. 21, 1922. Patient caught cold Dec. 27, 1921. All the upper air passages became inflamed and a frontal sinusitis developed eleven days later. Daily intranasal treatment of argyrol was given and free drainage was maintained by the aid of adrenalin and a mild cocain application. On account of a bronchitis the patient could not get to our office for an *x*-ray treatment for two weeks after the beginning of the sinus infection. After one treatment the pain and tenderness began to disappear. Within one week the discharge stopped. Incidentally the patient was cured of a chronic catarrhal condition, of which he had complained for a year.

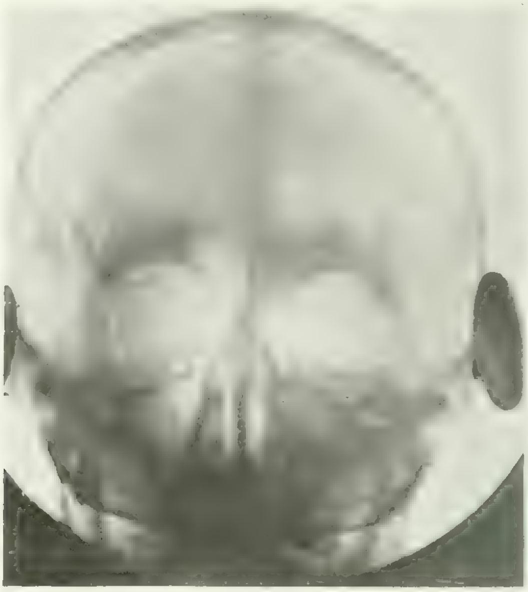


Fig. 4. Case XI. July 11, 1922. Right frontal and right antrum.

Case III. Female. Feb. 1, 1922. Intranasal examination revealed pus coming from the right antrum. The patient had had a yellowish nasal discharge for two months. The *x*-ray film revealed definite cloudiness of both frontals as well as the right antrum. Four treatments were given at four-day intervals. The discharge lessened and finally disappeared in about four weeks.

Case IV. Male. March 13, 1922. This patient came in for relief of pain over the eyes. The *x*-ray film showed an increased density of the left antrum. Intranasal examination revealed only a white mucous discharge. However, a one-minute treatment was given and prompt relief from pain followed within a half-hour. Pus appeared the next day and lasted only twenty-four hours. No further treatment was given. This case should be regarded as having received the *x*-ray treatment during the acute catarrhal stage.

Case V. Female. March 17, 1922. The patient complained of pain over the left eye, of one week's duration. Intranasal examination revealed considerable pus in the left nostril. The *x*-ray film showed slight cloudiness of the left frontal and marked cloudiness of the left antrum. Two *x*-ray treatments were given, a week apart. All symptoms and discharge had disappeared at the end of two weeks. Four months later a re-examination was made. All trace of the frontal sinusitis had disappeared on the *x*-ray film. However, the cloudiness of the antrum had increased.

Case VI. Female. March 21, 1922. Intranasal examination revealed pus pouring out over the left inferior turbinate. The *x*-ray film showed that only the left antrum was involved. Only two *x*-ray treatments were given this patient. All symptoms and the discharge disappeared within ten days. This patient had had symptoms of a sinusitis for only two weeks.

Case VII. Male. March 28, 1922. The patient complained of pain in the region of the left antrum following an acute coryza. Intranasal examination revealed pus coming from the antrum. The usual intranasal applications and anodynes were given for two days. As soon as the patient could come to the office, the *x*-ray examination was made and the left antrum was found to be the only sinus involved. Two *x*-ray treatments were given, three days apart, with relief of all symptoms and the discharge within one week.

Case VIII. Male. April 4, 1922. This patient had been ill for four months as the result of the flu in December, 1921. After his pneumonia cleared up in January he complained of pain in both antra and a greatly increased nasal discharge. *X*-ray films made in April showed marked infection of both the right and the left antrum. This patient received two *x*-ray treatments a week apart, all his nasal discharge disappeared within two weeks from the first treatment, and he returned to work a week later. No irrigations had been given either antrum. In the writer's opinion, this case would soon have resulted in a chronic sinusitis.

Case IX. Female. June 8, 1922. The patient had the flu in January, 1922, and gave a history of repeated "colds in the head" for five months. About June 1st a severe pain began over the right eye and in the right cheek and temple. On June 8, 1922, the *x*-ray films revealed a marked cloudiness of the right antrum. An *x*-ray treatment was given the same day and repeated three days later. Two other treatments were given at weekly intervals. It took about three weeks from the first treatment for all the discharge to disappear.

Case XII. Female. July 24, 1922. The patient caught cold about July 10th, and in less than ten days began to complain of severe pain over the left eye. Upon intranasal examination, July 24th, free pus was seen coming down from the left frontal. Roentgenograms were made and definite cloudiness was seen in both frontals, left ethmoid and left antrum. A two-minute treatment was given the frontal sinus from the lateral position. Two days later it was treated anteriorly. The left antrum was also treated at this time. Marked relief was given by the first treatment, for twelve hours, and complete relief by the second treatment. All drainage ceased within five days.

THE ROENTGEN THERAPY OF TINNITUS AURIUM*

BY LYELL CARY KINNEY, M.D.

SAN DIEGO, CALIFORNIA

TINNITUS is the most distressing symptom in ear pathology. It is the chief complaint of the ear cases referred for roentgen therapy, and the control of this symptom is the index of success or failure.

Serious roentgen therapy of ear conditions during the past seventeen years in the European clinics has not yielded encouraging results. The first work in *x*-ray therapy is by Joulin in 1908, who reported 10 cases of otosclerosis treated by small weekly doses of *x*-ray, 6 of which showed improvement of the tinnitus and some improvement in voice perception, but there was no improvement to objective tests. Ortloff, in 1913, reported 10 cases in which he found that the slight improvement was invariably followed by a return of the tinnitus and deafness. Siebenman, of Bale, has experimented for nine years with roentgen therapy in otosclerosis and concludes: "The results are only to a small degree positively encouraging."

Two years ago, the subject was revived by Dr. C. F. Stokes who reported astonishingly good results from "electronizing the pituitary auditory region" with minute doses of *x*-rays.

Exaggerated rumors of such results have come to the West and our otologists are asking for the cooperation of the roentgenologist in the treatment of tinnitus aurium.

Persistent tinnitus is usually the symptom of organic pathology. It may come as the result of a neuritis of the eighth cranial nerve, tuberculosis, suppurative otitis media or disease of the labyrinth. Most frequently it is a symptom of otosclerosis or chronic otitis media, and the treatment of tinnitus means an attack upon one of these two types of pathology.

The cause of otosclerosis has been assigned to the whole list of faulty metabolism, heredity and infection. It is probably not of endocrine origin, for the disease occurs in healthy individuals who show no other symptoms of glandular pathology. On the other hand, patients suffering from glandular deficiencies such as acromegaly, Addison's disease or hypothyroidism show no tendency toward otosclerosis. Whatever the cause, the pathology of otosclerosis consists in changes in the bony capsule of the internal ear. There is absorption of the normal bone in front of the oval window which starts around the capillaries of the Haversian canals accompanied by increased vascularity and overgrowth of the cartilage cells. The absorption is followed by fibrosis or the deposit of a typical loosely trabeculated bone. Exostoses and bone deposits occur around the foot of the stapes, resulting in a true ankylosis. Later there are areas of osteitis throughout the bony capsule of the cochlea, followed by nerve degeneration. Whether these bony changes are trophic or inflammatory, they closely resemble the bone pathology in hypertrophic osteoarthritis. The progress of the disease is insidious and the symptoms of tinnitus and deafening are rarely noticed until there are advanced bony deposits around the articulation of the stapes.

With this pathology in mind there are only two things that can be expected from radiation: control of the capillary congestion and checking of the cartilage-cell proliferation. In other words, the most that can be accomplished is arrest in that stage of bony deformity to which the case has arrived. Thus any treatment of the tinnitus resulting from otosclerosis offers very little.

I have had one case where *x*-ray treatment has relieved the tinnitus and there has been improvement in the deafening. My other cases were absolutely not influenced by *x*-ray. Fortunately, otosclerosis is rare.

Tinnitus is usually a symptom of a chronic inflammation of the middle ear and Eustachian tube with the source of pathology in the nasal pharynx.

The lower half of the Eustachian tube is surrounded by a cylindrical layer of adenoid tissue and the mucosa of the pharyngeal orifice is padded with cushions of adenoid cells. This adenoid tissue is subject to the same infection and hypertrophy as that in the pharynx, and such infection will result in a mechanical obstruction within the tube. The outlet of the tube may be obstructed by adenoids or polypoid turbinates. Any obstruction or inflammation in the pharynx will result in altered air tension and infection in the middle ear with the resulting symptoms of tinnitus and deafening.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12-16, 1922.

The treatment of this type of tinnitus and deafness consists in the removal of the pathology in the pharynx and the restoring of normal aeration and drainage to the middle ear. It has been proven that the *x*-ray will play a definite part in removing certain of these causes. The adenoid tissue in the pharynx can be controlled by *x*-ray. The swollen adenoid layer of the Eustachian tube and the adenoid collar at its outlet can be eliminated by *x*-ray. The latent infection in the middle ear and pharynx can, in some cases, be destroyed. Capillary engorgement and early fibrosis in the middle ear can be lessened. All these are factors influencing tension, irritation and fixation in the middle ear. It is therefore logical to expect improvement in chronic otitis media and the resulting tinnitus from *x*-ray treatments. But here, as in otosclerosis, no change can be expected in terminal pathology, such as dense adhesions, bony changes in the ossicles or resulting degeneration of the labyrinth.

Realizing that any permanent relief must come from changes in pathological anatomy and not from endocrine stimulation, I have given a reasonable quantity of radiation. The dose has been small, but calculated to deliver approximately one-half of an erythema to both ears in one month. I have used 135 kv., 5 ma., filtered through 6.0 mm. of aluminum at 60.0 cm. distance through a portal 5.0 cm. in diameter. The exposures have been two minutes on each side daily for eight doses with a weekly interval of rest. The average case receives three such series, when, if there is no relief, the treatment is abandoned. If there is appreciable improvement, treatment is continued at monthly intervals.

Practically all the patients complained of increased tinnitus and rhinitis, and some of dizziness for the first three or four treatments. If there is going to be an improvement in the tinnitus, it will usually begin at the end of the first week.

This technique has been followed through a series of 14 cases of tinnitus from chronic otitis media, because of definite requests from our otologists for "minute frequent doses." In 40 per cent of these cases, we have found permanent decrease in the tinnitus and marked improvement in the hearing to objective tests.

In conclusion: The suffering from tinnitus is most distressing and some cases obtain definite relief from *x*-ray therapy. When tinnitus is the symptom of otosclerosis, the most that can be hoped for is to prevent its increase, and then only in the early cases. When tinnitus is a symptom of chronic otitis media, improvement may be expected from roentgen therapy in some cases. Such improvement is due to the known anatomical changes produced by the *x*-ray, and there is no reason to attribute it to endocrine stimulation.

The *x*-ray should be considered only as one of the necessary factors in clearing up the infection and obstruction in the pharynx, Eustachian tube and middle ear.

I want to thank Dr. Andrew Wessels of San Diego for his earnest cooperation in this work.

BIBLIOGRAPHY

1. Gray. Otosclerosis. *Laryngoscope*, xxxi, no. 7.
2. Hays. Modern conception of deafness. *Laryngoscope*, xxxi, no. 9.
3. Webster, J. H. *X*-Ray Treatment of two cases of otosclerosis. *Arch. Radiol.*, xxvi, 69.
4. Jaulin. Traitment de l'otite scléreuse par les rayons X. *Arch. d'électric. méd.*,1908, p. 92.
5. Ortloff. Über therapeutische Versuche mit Roentgenstrahlen bei der Otosclerose. *Arch. f. Ohrenh.*, 1912, xc, 233.
6. Stokes, Chas. F. Discussion. *Laryngoscope*, xxxi, 739.

DISCUSSION ON PAPERS OF DRS. McCOY, OSMOND AND KINNEY*

Dr. Hickey. The reading of medical history is both interesting and instructive. From it one gains the ideas of different types of treatment which come and last for a short time and then fade away. The lesson to be learned is that new lines of treatment should always be viewed conservatively.

I hope Dr. Osmond will pardon me if I discuss his paper frankly. Personally it does not seem to me to prove the point which he endeavors to bring out. For many years I was engaged in nose and throat work and one of the things that I well remember is the remarkable way in which many cases of sinus trouble would get well without any very special line of treatment. A great majority of the cases of acute sinusitis tended to spontaneous recovery.

In considering the *x*-ray treatment of sinusitis we feel that we must approach the subject with a good deal of conservatism in view of what we know about natural tendency to get well through the curative powers of nature. The exceptions to this rule are where the infection comes from the alveolar process. While the report of Dr. Osmond is very encouraging and stimulates us to further observation, still I do not feel that we should go away from the meeting with the idea that his paper is any more than a preliminary report.

In regard to the treatment of defective hearing, I am very glad to state that the paper of Dr. Kinney has crystallized some ideas on the question which is so popular at the present time. The treatment of defective hearing with *x*-ray seems to be one of the favorite indoor sports of roentgenologists at the present time. It must be confessed, however, that it is very difficult to classify the results we are getting, inasmuch as we are dealing with a class of patients who are very anxious to recover and who watch their own symptoms very minutely. When the president asked me to discuss this paper, I had treated at the time some three or four cases with the so-called Stokes method. I had obtained no definite results. I then went over to the Otologic Department of the University of Michigan and asked them to send over some of their cases of defective hearing. We treated a number of cases according to the advised technique and found when they were re-examined by the Otologic Department that there was no benefit derived. An interesting feature, however, was that certain of the patients seemed to think they were some better.

An interesting observation was that we placed some plates against the head at the time of treatment and found that the amount of ray which went through the skull was scarcely enough to produce any perceptible shadow upon the plates. Certainly the quantity of ray which the intracranial tissues received was very small.

The type of treatment which Dr. Kinney describes is, we think, quite rational and marks a distinct advance in the treatment of defective hearing.

Dr. Law. I do not know why I am to discuss this, because as you all know, I fight shy of treatments. The only thing I can say is regarding this Stokes treatment.

I heard about Stokes treatment and was asked to go up and investigate it. I know very little about dosage except what I have heard. It hardly seems possible to me that a 4-in. gap, 30-in. distance, 5 ma. for 20 odd seconds would do much good. However, it was worth the trial, because certainly the *x*-ray does queer things, and no doubt there are things we know nothing about so far. We cannot condemn any use of the *x*-ray until it is thoroughly investigated.

Dr. Stokes gave us the privilege of sending in a number of cases at any time when we cared to. Cases were sent up there and strangely, every one of those patients said they heard better, that is, the sounds seemed clearer. Then they were tested, as they are always tested, and with the exception of the voice test there was no difference. It is pretty difficult to make the voice give the same density twice in succession, especially when you are anxious that the patient should hear better. Then we tested them under the best known scientific methods, sent them up for treatment, and re-tested them without any change in the ultimate results. That was not quite sufficient, so the said cases were treated elsewhere, and there was no change, hence, there may be a certain psychological element there. However, we should not condemn the thing until you, who understand those things and understand the technique, have thoroughly investigated it. Personally, I am not in a position to do it.

Dr. Kinney's work is well worth thorough investigation. I am sure that when I get back to New York, we will see what we can do with some of these obstinate cases. As Dr. Hickey said, all acute cases have a tendency to recover for a few days at a time.

---

* Papers read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922. That of Dr. McCoy appeared in March, and those of Drs. Osmond and Kinney precede this discussion.

I am sorry Dr. Osmond showed plates which in the second examination were not the same as in the first. In none of them did I notice a tendency to much illumination. It is well worth trial because we know that in many cases going for *x*-ray examination of the sinuses or mastoid, the patient is relieved and sometimes the discharge increases for a time and suddenly decreases. Now we know there is an electrostatic field encircling the patient and this does help so far as certain things are concerned. All these things are new and I think instead of condemning them we should try them, but with hundreds of cases rather than with a few cases.

Dr. Remer. It seems that the natural tendency in a new field is condemnation. While I do believe, on the other hand, that it requires a certain amount of definite and long-continued work to bring out definite ideas and results, at the same time, I do not think we should be too prompt to condemn.

I do feel in regard to Dr. Stokes' work, that the amount of rays used, the way in which they were used, and the amount of dosage obtained could scarcely result in any advantage. In Dr. Kinney's work there is, as Dr. Law said, a definite pathological condition. Further, I believe that in our work the cases must be selected to obtain results: then where you have an active inflammatory pathological condition, with a sub-acute inflammatory condition, you are apt to get results. The *x*-ray will have no influence on a negative result. In most of the cases of tonsils treated, you find adenoid tissue and lymphoid tissue. You also find a certain amount of inflammatory condition surrounding the Eustachian tubes. Dr. Kinney states that he uses the method which is recognized. In that way you do get a definite result of the pathological condition surrounding the Eustachian tubes. Where there is that condition you undoubtedly have tinnitus. By relieving the condition, you open up the pocket, and in that way, get relief of the tinnitus. Your end results are not obtained by changing the anatomical condition, but by changing the pathological condition.

In regard to treatment of sinuses I have had no experience, and with Dr. Law, I am rather inclined to be skeptical; yet I do not think we should be too quick to condemn. However, we must have a larger number of cases than have been reported to accept it.

Dr. Stewart. Last winter I had the privilege of hearing Dr. Stokes, and as I had not had any experience, I could not say much except with reference to the dose indicated. I said that I did not believe a sufficient amount of *x*-ray was given possibly to benefit these patients, and I thought that probably the effect was entirely psychological. Stokes' response was that a great many had stated the same thing, but he considered 2,000 cases sufficient to overcome that argument on psychology.

Dr. Lewald. I have some definite evidence along this line, i.e., a more delicate instrument for testing the hearing has been evolved in the last few years—the Fowler Audiometer. This gives much more accurate intensity and frequency measurement than any instrument heretofore devised.

Dr. Edmund P. Fowler, otologist, has tested ears before and after treatment by Stokes, and he told me very definitely that he could detect no improvement in the hearing of patients, although Stokes was reported to have assured them they were greatly benefited or cured of their deafness, and the patients themselves temporarily imagined this to be true.

Dr. Kinney (closing discussion). Last year Dr. Webster published a description of two cases of otosclerosis that he believed had been arrested. Immediately Dr. Barclay called him to task for it, maintaining that it was untimely and aroused unwarranted hopes. I thought the same thing when we began to hear about the treatment of ear conditions from the East. We are approaching our cases in just that way, trying to discourage any psychic element. We tell them we do not expect any relief from the deafness but will try to help their head noises.

I do not want you to go away from this meeting thinking that I am suggesting anything else than helping the tinnitus in some cases, and in these cases attacking a definite pathological condition. Of course the results in a small series prove nothing. This series was presented simply to start a discussion to see what you gentlemen were thinking along this line. It is an effort to obtain a rational basis for the relief in some of these people who are improving. I do not believe that the relief comes from electronizing the pituitary, but that what improvement occurs comes from known demonstrable changes in pathological anatomy.

Dr. Osmond (closing discussion). My purpose in presenting this paper before the Society is to get you to use this method in some sinus cases. My series is not large; however, I am firmly convinced of the value in this method of treatment. If each one of you will use the method on a small series of cases, a more convincing conclusion for you can be formed from the total number. Choose your cases. I realize that a great many acute sinuses will get well of their own accord. On the other hand, we know that some do not. If we can prevent an acute sinus from becoming chronic, it is worth while to do it.

While receiving my post-graduate instruction in nose, ear and throat work, I was impressed by the difficulty encountered in the treatment of chronic sinusitis of the accessory air sinuses and by the remark of Dr. A. J. Houston of San Francisco at that time: "What in the world can be done to stop these chronic sinusitis cases? I have been searching in Europe and this country in hope of finding something more satisfactory in the treatment of this condition."

It is a difficult thing to cure chronic sinusitis; therefore, I believe that we should do our part to help to prevent a condition from becoming chronic. I do not think there is much value in treating chronic sinusitis with the *x*-ray. If any of you try it, be sure to make an intranasal examination first to see if pus is there, and to see if it is draining. If there is not sufficient drainage, you might do harm.

In regard to the two positions, the following method was used: on every sinus case two posteroanterior exposures were made, and one lateral. The posteroanterior position consisted of one made in the usual 23-degree angle and the other in the Waters position. If either position ruled out sinusitis, the case was not used in the series. If both positions showed sinusitis, the film was chosen for exhibit which most clearly outlined the condition.

In closing, let me say that if any of you have ever had sinusitis and have had it treated by irrigation, you would appreciate by contrast the absence of discomfort afforded by *x*-ray therapy.

THE VALUE OF THE ROENTGEN STUDY OF MASTOID DISEASE IN CHILDREN UNDER FIVE*

BY WM. A. EVANS, M.D.

DETROIT, MICHIGAN

THE practice of general roentgenology affords one an excellent opportunity for the study of anatomy in all of its variations. Early in my work in this field, my observations of mastoid structure in infants and young children were contrary to the usual teachings and writings. As my experience with clinicians broadened, and I was called upon to interpret abnormal mastoid structure in clinical terms, I became convinced that those who denied the value of the roentgen diagnosis in mastoid disease in early life probably spoke from inexperience or misinformation. So, when it was stated in the very excellent work on "Mastoids"[1] by the leading authority in this branch of our work that "Except in very unusual cases the mastoid process does not show cellular development before three years of age, and usually not until about the fifth year," it seemed advisable to publish our observations and experiences, since they were not in accord with the generally accepted ideas.

Recent publications in English by anatomists on the structure of the mastoid process agree with the older works as to the tardy pneumatization of the mastoid.

Goldstein,[2] in 1921, stated: "The mastoid process contains no air cells at birth, but toward puberty the process becomes pneumatic."

Bigelow,[3] of Providence, through his knowledge of the work of Cheadle, was familiar with the early formation of pneumatic cells, but was impressed with the frequency of the persistence of the infantile type to adult life, but the frequent development of the adult type of mastoid structure in early childhood was not noted.

Professor E. Zuckerkandl,[4] the leading European anatomist on the temporal bone, also observed the early formation of pneumatic structure, and states that in the second year cellulae can be present, and in the third year the process resembles frequently the process in the adult. It will be instructive to quote verbatim from the above article as to the embryology of the mastoid:

"Mastoid process of the child, the pars mastoidea, is already present in the embryo; a cone-like, pneumatic process develops, only very much later. Of the pneumatic spaces, first the antrum appears, which Schwartze and Eysel have observed already in the five-months' embryo. In the newborn there is a little knob at the spot of the mastoid process, the anterior plane of which is taken up by a triangular process of the squama (lamina mastoidea squamae). Between both there is to be found the fissura mastoidea which passes away only after the complete second year and which contains a connective tissue, continuation of the outer periosteum. Not infrequently, portions of the same or the whole suture persist. This is important to consider, on account of its relation to the propagation of diseased processes from outward inwardly, and vice versa. The formation of the mastoid cells begins at the posterior end of the mastoid antrum, and continues at first horizontally toward the sigmoid sinus, so that the upper portion of the pars mastoidea becomes pneumatic sooner than the mastoid process. The cell formation in the same also starts through the antrum which pushes a prolongation toward the tuberculum mastoideum. This evacuation grows in the course of the first month. At the end of the first year the tuberculum contains already a comparatively large cavity and becomes cone-shaped. In the second year cellulae can be present, and in the third year the process resembles frequently the process in the adult."

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a later number of the JOURNAL.

Very little reference is made to the value of *x*-ray diagnosis in the literature on the clinical aspect of mastoid disease.

In Philip D. Kerrison's book,[5] "Diseases of the Ear," published in 1921, no mention is made of this method of diagnosis.

Amberg,[6] has an article in volume xxvi of *The Laryngoscope*, in which he recognizes the value of the aid given by the *x*-ray method of study, but his cases did not include a patient under five years.

Bigelow,[3] mentions the failure of twenty-one out of twenty-five otologists to recognize the value of the *x*-ray examination in acute infections of the middle ear and its complications.

Articles in the roentgen literature on this subject are few. Sidney Lange,[7] in 1909, made the following statement:

"Upon the mastoid skiagrams of children under ten years of age the mastoid appears entirely spongy or diploetic, there are no visible cells and the tip is undeveloped. The tip at this time consists simply of an inner and an outer table, with little cancellous bone between, and shows no structure upon the skiagram. From ten to fifteen years the mastoid takes on the pneumatic characteristics, large cells appear and grow downward toward the tip, its diploetic structure finally giving way to the more or less pneumatic adult type." No doubt his later experience has proven that the above statement is not in accordance with the facts.

Dr. Wm. H. Stewart,[8] of New York, as early as 1913, in an article entitled "Radiographic Findings Illustrating the Anatomic Development of the Mastoid Bone," states that examinations of normal children as to mastoid structure demonstrated that distinct and well-formed pneumatic cells occur as early as two years, and Gerber,[9] in collaboration with Bigelow, agrees with Stewart as to the early presence of pneumatic cells.

The material for this paper was obtained from Harper Hospital and our office records for the first six months of the year 1922. In that period 254 cases were referred for mastoid examination. Classified according to age, we find that 7 were less than one year of age; 46, less than five years of age; 52, from five to ten years of age; and 147, over ten years of age. Of the 53 cases of less than five years, 39 were operated on and operative results were available. We were able to classify, anatomically, all of the proven cases according to the classification of Cheadle, which arrangement was found acceptable by Gerber and Bigelow. That is, three types of infantile mastoid: First, the diploetic form; second, the dense form; third, the pneumatic infantile; and finally, the adult type. Of the 39 cases, 6 were classified as the diploetic infantile; 1 as the dense infantile; 13 as the pneumatic infantile; and 19 the adult type.

These figures indicate that pneumatization of the mastoid structure occurs much earlier than all the former writings indicate, and that the adult structure is found in a much larger proportion than was formerly believed.

We further classified the types in our operative cases as to years. Of the patients less than one year of age, 5 presented the pneumatic type, and only 1 the diploetic type. In the second year we found 1 of the diploetic infantile; 1 of the dense infantile; 3 of the pneumatic infantile; and 3 of the adult type. In the third year, 2 presented the diploetic type, 1 the pneumatic infantile, and 5 the adult type. In the fourth year, 2 were of the diploetic infantile type, 2 of the pneumatic infantile, and 7 of the adult. In the fifth year, we found 1 of the pneumatic infantile, and 5 of the adult structure.

TYPES OF MASTOID STRUCTURE

Age	1	2	3	4	5	Total
Diploetic	1	1	2	2		6
Dense		1				1
Pneumatic infantile	5	3	1	2	1	12
Adult		3	5	7	5	20
Total	6	8	8	11	6	39

Since the above conditions exist, stereoscopic plates of the mastoid regions of children will give information comparable to that of adults, and in all cases of complicated middle-ear infection, plates should be obtained, so that the surgeon can know in advance the area he is to explore, especially as regards type and extent of structure, and direction that the infection probably took.

Even in those cases in which there is no cellular structure, that is, where the structure is diploetic or dense, we believe that valuable information can be obtained from stereoscopic plates. It is not possible to be as exact in the classification of the degrees of bone change, but in cases where there is definite disturbance of bone structure, the lesion can be usually demonstrated.

In the interpretation of the mastoid plates as regards disease and clinical indications, we have followed the classification of the changes adopted by Dr. Lange:[10] that is, the mild or first degree mastoiditis in which there has been a replacement of the air content with exudate but no change in the cell walls; the second degree, in which is noted in addition to the absence of air content, a change in the bone structure, the cell walls being indistinct and hazy, and in places possibly a coalescence of a number of the cells; the third degree, in which practically all of the cell structure has broken down. First degree mastoids are not considered surgical, but the second degree is usually surgical, and the third degree, always surgical.

In all the cases studied in which the degree of pathology and surgical indications were stated, the findings at operation coincided with the pathology described by the roentgenologist, with the exception that in several cases the destructive process had gone beyond that suggested by the roentgenograms. In two cases the indications for treatment, as suggested by the roentgenograms, were disregarded by the operator, and a second operation was necessary: that is, the surgeons considered a drainage of the antrum sufficient when there was roentgen evidence of pneumatic structure which was infected, and it was later necessary to re-operate and remove the infected cellular structure.

Continuing the quotation from Law's book on "Mastoids:"[1] "This fact (referring to the absence of cellular development under the fifth year), together with the difficulty in immobilizing the head of an infant—" We agree with the technical difficulties and have found it necessary in practically every case to give an anesthetic, but under these conditions very satisfactory plates have been obtained. It is important, of course, that the plates be stereoscopic, and that the technique used be one that shows to best advantage the mastoid area. Our custom is to place the patient in the prone position, with the head turned first to the right and then to the left on an angle board; the head is fixed by a mechanical device and further held by an assistant. The central rays for the first plate are directly vertical, and for the second plate the shift is made backward and the central rays angled anteriorly.

Of late we have been using the so-called "flash" method, to obviate the necessity of a general anesthetic in obtaining plates. The technique of this involves the use of double-coated films and screens; the voltage varies from 55 to 70,000; about 30 milliamperes, and about 1/10 to 1/30 of a second, depending upon the age of the child and the size of the head.

CONCLUSIONS

1. Pneumatic mastoid structure is frequently observed before the end of the first year of life.
2. The adult mastoid structure can be observed as early as the second year.
3. Stereo plates of good quality, of children under five, have definite diagnostic and prognostic value.

BIBLIOGRAPHY

1. Law, Frederick S. Mastoids: Annals of Roentgenology. Paul B. Hoeber, New York, 1920.
2. Goldstein, Joseph. *Ann. Otol., Rhinol. & Laryngol.*, June, 1921.
3. Bigelow, F. Nolton. Types of mastoid structure with special reference to their recognition by means of stereoradiography. *Ann. Otol., Rhinol. & Laryngol.*, 1918, xxvii, 54.
4. Zuckerkandl, Prof. E. *Handb. d. Ohrenheilk.*, vol. i, pp. 33, 34.
5. Kerrison, Philip D. Diseases of the Ear. Philadelphia, 1921.
6. Amberg, Emil. Some remarks on the *x*-ray diagnosis of mastoiditis. *Laryngoscope*, 1916, xxvi.
7. Lange, Sidney. The *x*-ray examination of the mastoid region. *Am. Q. Roentgenol.*, Dec., 1909, ii, no. 1.
8. Stewart, Wm. H. Radiographic findings illustrating the anatomic development of the mastoid bone. *Ann. Otol., Rhinol. & Laryngol.*, 1913, xxii, 677.
9. Gerber, Isaac. Some observations of the mastoid structure as revealed by roentgen ray examinations. Am. J. Roentgenol., Jan., 1919, p. 1.
10. Lange, Sidney. Practical results in *x*-ray examination of the mastoid. Am. J. Roentgenol., June, 1914, i, no. 8.

A REVIEW OF THE TREATMENT OF HYPERTHYROIDISM BY ALL METHODS, WITH A SUMMARY OF THE AUTHORS' EXPERIENCE WITH ROENTGEN THERAPY*

BY THOS. A. GROOVER, M.D., A. C. CHRISTIE, M.D., AND E. A. MERRITT, M.D.

THE rational treatment of hyperthyroidism had its origin in the thyreogenic theory first clearly set forth by Moebius in the year 1886. Exactly a century before that time, Parry had recognized typical cases of exophthalmic goiter, and during the intervening century many noted names were connected with the study of the disease, notably: Graves, Basedow, Stokes, Charcot, and Trousseau.

The foundation of all subsequent work was laid by Moebius who brought forth the theory that "Basedow's disease is an intoxication due to the morbid function of the thyroid gland" and who stated that the disease can be looked upon as a "hyperthyroidization." Clinical observation and experimental work since that time have served to establish thoroughly the correctness of his views. The term "hyperthyroidism" now has a sound scientific basis. It serves to designate a syndrome characterized by an increased metabolic rate and by certain well-known clinical manifestations.

Kendall's work in 1914, in separating the pure chemical compound, thyroxin, from the thyroid gland, his subsequent work in proving that thyroxin is the active principle of the thyroid, and finally his demonstration of the chemical composition of this active principle, not only added greatly to our knowledge of diseases of the thyroid gland, but is one of the most complete and beautiful pieces of work in the entire history of medical science.

The investigations of Du Bois, of Plummer and his associates, Boothby and Sandiford, and of Means and Aub, have established beyond reasonable doubt that the basal metabolic rate is an accurate diagnostic measure for the recognition of the presence or absence of hyperthyroidism. Plummer has clarified the problem by showing conclusively that there are two types of hyperthyroidism: true exophthalmic goiter and adenoma with hyperthyroidism. The two conditions differ not only in their underlying pathological anatomy, their mode of onset, their clinical course and their prognosis, but also in their treatment.

---

* Read at the Midwinter Meeting of the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J., Jan. 25-27, 1923.

It is not our intention to attempt to recount in this paper the different methods that have been used in the treatment of hyperthyroidism. Their name is legion. The use of iodine and the iodides internally, and of iodine or iodoform for injection into the gland; the administration of thyroid or thymus gland preparations, of sera from thyroidectomized dogs or sheep; the milk of thyroidectomized goats; and the serum of Rogers and Beebe, have all been used and now generally abandoned. Today only two methods are in general use: surgery and roentgen-ray therapy. We wish to discuss the subject under the headings of (1) general management, (2) surgical treatment, (3) roentgen-ray treatment.

The general management of patients with hyperthyroidism is of major importance, whether the ultimate treatment is to be surgery or the roentgen-rays. It should be as well understood and as carefully carried out by the roentgenologist as it is by the surgeon or internist. We venture to recall here the details of the general management of this disease only because we believe that many who are called upon to treat patients with hyperthyroidism are lax in this very essential part of its treatment.

Rest is the first indication, and whether it is to be absolute or relative depends upon the severity of the disease. In severe cases a rigid regime of rest in bed and passive exercise must be carried out. The details of such a regime cannot be described here. In cases with mild symptoms, definite directions must be given as to amount of exercise, the necessity for long hours of sleep, and the avoidance of all unnecessary activity and of working to the point of fatigue. Rest to the mind is equally as important as rest to the body. Mental stress and worry must be avoided so far as possible. The physician must use every means in his power to gain the patient's confidence, to tranquilize her mind, and to create an atmosphere of optimism.

The diet must be regulated with care. Overfeeding is to be avoided, but in a disease characterized by increased catabolism, it is essential for the patient to have a large amount of food of the most nourishing kind possible. Much care should be used to make the food tempting to the appetite and at the same time of a kind that is easily assimilable and of high caloric value. It is equally important that the intake of fluid be as great as possible in order to assist in the elimination of waste matter produced by the increased metabolism. Hertzler recommends lemonade for this purpose, and to increase the caloric value of the food he adds about 50 gm. of lactose to each glassful.

Cardiac symptoms, if marked, may need special treatment. Tachycardia and palpitation usually subside when the patient is put at rest. If this does not occur, an ice-bag placed over the heart is often beneficial.

Digitalis is of great value in decompensation and fibrillation of the heart, but should not be used routinely because of its tendency to cause gastric irritation.

The nervous symptoms and insomnia will be greatly decreased by such general hygienic measures as rest, proper diet, and fresh air in the sleeping room. If insomnia persists, a full dose of sodium bromide at bedtime may be effective. Administration of opiates is very rarely justifiable in this disease.

Gastric or intestinal complications are usually controlled by careful attention to the diet; but if crises occur, lavage of the stomach and colon and mild cathartics may be necessary.

An essential element in the general management of hyperthyroid cases is the elimination of all sources of focal infection. The number of cases arising after influenza and tonsillitis strongly suggests the possibility of infection as a primary cause of the disease. Special attention should be directed to the nasal accessory sinuses, the tonsils, and the teeth, and to the possibility of the presence of a chronically infected gall-bladder or appendix.

Surgical Treatment. The history of the surgical treatment of goiter is essentially the history of the art of general surgery. Some of the greatest names in surgery are connected with the operation for the extirpation of goiter. Until about 1890 all the important advances had been made by Swiss, German and Austrian surgeons. The most prominent among them were Theodor Kocher and Mikulicz. Tillaux in 1880 and 1881 operated on two patients with hyperthyroidism and Rehn operated for exophthalmic goiter in 1884. The work of Halsted in this country is too well known to need comment.

The good results obtained by surgical treatment established it, early in this century, as the treatment of choice for hyperthyroidism. During the past ten years the technique of operation and the surgical management have been so perfected by the work of C. H. Mayo, Crile, and others, that the mortality from operation has been greatly reduced and the end-results much improved. The generally accepted surgical treatment of hyperthyroidism may be given by summarizing a description by Pemberton[1] of the method of treatment carried out at the Mayo Clinic. The "patients with exophthalmic goiter fall into one of three groups: (1) patients on whom a primary thyroidectomy can be performed with reasonable safety, (2) patients concerning whom the wisdom of advising thyroidectomy is doubtful, (3) patients in whom indications for extended observation or preliminary measures are clearly defined."

In the first group are those patients whose basal metabolic rate is usually not above plus 55 per cent, in whom the severity of the disease is not increasing, and who have suffered no great loss of strength or weight. The second group comprises those whose basal metabolic rates are only a little higher than plus 55 per cent, but about whom doubt exists, possibly because of recent loss in weight, marked loss of strength, presence of slight edema, or undue apprehension on the part of the patient. A preliminary ligation of the superior thyroid is done on patients of this group and if no undue reaction occurs, it is followed by thyroidectomy in from seven to ten days. It is sometimes necessary to do a second ligation before the resection if there is marked reaction after the first. Group three comprises patients who must be kept under extended observation and who may need much preliminary treatment before a resection is advisable. The indications for this are a high metabolic rate, plus 70 per cent or higher, actual crisis or recent progression of the disease, extreme apprehension, marked weakness, loss of weight, chronic visceral changes, cardiac dilatation and chronic infection. Patients in this group are put at rest and carefully observed until the simplest surgical procedure, such as injection of quininurea or boiling water, may be done. This may be followed by successive ligations of the superior thyroid vessels, the interval between operations depending upon the degree of reaction. In most cases the ligations produce such improvement that thyroidectomy may be done safely.

The general management of patients with hyperfunctioning adenomatous goiter is the same as for those with exophthalmic goiter; but preliminary ligations, etc., are rarely necessary in these patients.

Pemberton gives the following statistics for the Mayo Clinic from July 1, 1920, to July 1, 1921. "Of the 281 patients with hyperfunctioning adenomatous goiter, 4 died, a mortality of 1.4 per cent. Of 677 patients with exophthalmic goiter, on whom 1,224 operations were performed (ligations and thyroidectomies), 23 died, a mortality of 1.87 per cent by operations and 3.39 per cent by patients."

The following is Crile's statement of his mortality: "Since the adoption of the method described in this volume, we have performed 1,783 thyroidectomies, including 1,022 thyroidectomies for exophthalmic goiter, with 25 deaths, a mortality rate of 1.4 per cent; and 783 ligations with 6 deaths, a mortality rate of 0.76 per cent."[2] It is impossible from this statement to determine the mortality rate in the patients with hyperthyroidism, since no separate figures are given for the mortality in either exophthalmic goiter or toxic adenoma. It is fair to assume that the mortality rate in the 1,022 cases of exophthalmic goiter was greater than that in the 1,783 cases which included simple goiter. The 6 deaths following ligations might also be fairly charged to the surgical treatment of exophthalmic goiter.

Examination of the available statistics of operative mortality leads us to the conclusion that in the hands of the most skillful surgeons, with every facility for preoperative and postoperative care, the operative mortality in patients with exophthalmic goiter is somewhere between 2 and 4 per cent, and in hyperfunctioning adenoma about 1.5 per cent. The operative mortality of the average good surgeon throughout the world is undoubtedly considerably higher than this.

The end-results of surgical treatment in the best hands can be judged from statistics compiled by Judd from cases operated upon at the Mayo Clinic,[3] comprising 100 cases of exophthalmic goiter operated upon in 1914, and 100 cases of toxic adenoma operated upon in 1917 and 1918. The average elapsed time since the first series was six years, and since the second series was two years. The exophthalmic goiter cases showed 65.8 per cent cured, 13.6 per cent markedly improved, 5.6 per cent slightly improved, and 15 per cent dead from all causes. The cases of hyperfunctioning adenoma showed 83 per cent cured, 5 per cent markedly improved, 1 per cent slightly improved, 2 per cent not benefited, and 9 per cent dead from all causes.

It is fair to conclude from available statistics that the surgical treatment of hyperthyroidism cures about 75 per cent of all cases operated upon, that there is an operative mortality of at least 3.5 per cent, and a certain unknown percentage of patients that are inoperable.

Roentgen-ray Treatment. The roentgen ray has been used in the treatment of hyperthyroidism since 1898. It was only with the advent of the Coolidge tube, however, that it became possible to control the dosage to an extent that enables different workers to imitate or duplicate each other's results. Since 1915 the majority of roentgenologists in this country have used, with minor modifications, the dosage then recommended by Pfahler, and the results throughout the United States and Canada have for that reason been rather uniform. In 1915 Pfahler and Zulick[4] made a thorough review of the literature of the roentgen treatment of hyperthyroidism, and five years later Pfahler[5] presented an excellent summary of roentgen and radium therapy in this disease. He presents evidence based upon his own experience and that of careful workers in Europe and America which has led him to the conclusion that roentgen therapy offers an equal chance with surgery for the cure of hyperthyroidism, and it is his opinion that "radiotherapy is the best form of treatment for toxic goiter." Our own experience leads us to complete agreement with these conclusions. That surgeons in general not only do not accept these conclusions, but reject them almost entirely, is shown by the fact that Hertzler, in a recent book, "Diseases of the Thyroid Gland"[6] does not mention roentgen treatment of hyperthyroidism; that Crile, in his book, "The Thyroid Gland"[2] discusses the treatment only to condemn it; and that such statements as the following may be found in the writings of many prominent surgeons. "With *x*-ray treatments remissions may occur just as with other methods of treatment. Our experience has been failure, or but temporary benefit" (C. H. Mayo).

The reasons advanced by surgeons for rejecting the roentgen method of treatment are as follows:

1. It has not been proven that the roentgen ray produces permanent cure of the disease.
2. The time necessary for roentgen treatment increases the opportunity for cardiovascular and visceral changes to occur, and a certain number die of hyperthyroidism while taking the treatment.
3. Subsequent operation upon the gland is rendered more difficult because of adhesions between the muscles, capsule and gland.
4. The function of the thyroid may be so reduced that hypothyroidism will result.

The first reason given that roentgen therapy has not yet been proven of permanent curative value should be examined in the light of the fact that the roentgen-ray treatment of hyperthyroidism is still in its infancy. It has been only since the advent of the Coolidge tube that we have been able to control dosage, and only since 1915 that there has been any uniformity in the method of treatment employed. Surgeons have been operating upon patients with hyperthyroidism for more than forty years and have been able to amass a great volume of statistics which prove the value of surgical treatment. The roentgen method is now somewhat in the situation of surgery between 1900 and 1905, when the so-called medical treatment was that usually employed; the burden of proof at that time rested upon the surgeon. Roentgenologists are only now becoming able to point to permanently cured cases of hyperthyroidism, and cannot yet speak in terms of definite percentages, because sufficient time has not elapsed. In the very nature of the case it is still impossible to offer definite proof of the percentage of patients that are cured by roentgen treatment, but many cured cases are now being reported. There is no doubt that the results already obtained justify the extended use of this method, and it seems certain that the results will be greatly improved as roentgenologists gain experience in management of this disease and as more accurate dosage becomes possible by improvement in apparatus and technique.

That neither the surgical nor the roentgen-ray treatment of hyperthyroidism is perfect in its results may be inferred from the following quotations. The first is taken from Crile's "The Thyroid Gland"[2] and the second from an article by H. M. Jones.[7] Crile says: "It is significant to note that many cases that come to operation have had *x*-ray treatment." Jones says: "It is significant to note that many patients who come in for *x*-ray treatment have previously been operated upon."

The danger that the hyperthyroidism will increase and produce further damage while the roentgen treatment is being carried out is probably not great. In practically all the cases that are affected favorably by the roentgen rays the symptoms will begin to abate after about a month, that is, after the second treatment. Our experience indicates that five or six treatments is about the average number required. The first four are given three weeks apart and the next two at intervals of one month. The total time of treatment is thus less than four months. After the fourth treatment it is an almost invariable rule that the basal metabolic rate decreases steadily, the weight increases and the entire clinical picture is one of rapid improvement. In the rare case that does not follow this course, we have found it of little or no value to proceed with the treatment after the sixth application. These patients are kept under observation for about three months if the basal metabolic rate is not excessive and the general symptoms not severe. Great improvement may take place during this time and the condition may be such at the end of the period that a cure may be hoped for by further roentgen treatment. There remains, however, the occasional patient who shows little or no tendency to improve after the fourth treatment and it seems to us much the better course with such cases to advise thyroidectomy rather than to proceed further with the roentgen treatment.

If this course is followed, there will probably never be any basis in fact for the surgeon's third objection, that difficulty of operation is increased by roentgen therapy. There is abundance of testimony by surgeons that operation upon the thyroid gland is rendered less difficult by previous roentgen therapy because of the reduced vascularity. It is safe to say that such would always be the case if the roentgen treatment were kept within the bounds indicated above, and beyond which there is probably nothing to be gained.

The fourth objection to roentgen therapy—that it is likely to produce hypothyroidism—can be dismissed as of no practical importance. If this were a real danger, it would constitute a strong argument for the efficacy of the roentgen rays in reducing thyroid activity. If it ever was a danger of any moment, it can be avoided almost with certainty by controlling the treatment with the basal metabolic rate. There is certainly no more danger of this accident after roentgen therapy than there is after thyroidectomy done by the average surgeon.

There would be no excuse for offering another method of treatment in this disease if surgery were free from danger, and if it always cured the disease.

Crile minimizes the danger of operation, stating that under the type of surgical management used by him the operative risk may be largely disregarded. The risk is real, however, and cannot be so lightly set aside in the face of the published statistics from many sources. We have quoted above statistics from the Mayo Clinic showing an operative mortality of 3.39 per cent in exophthalmic goiter, and we may fairly assume that the percentage is higher throughout the country. There is also a small but very certain mortality in the lesser operation of ligation of a thyroid vessel. The permanent cures effected by surgery may be judged by the figures quoted above from the Mayo Clinic, with 65.8 per cent of cures in exophthalmic goiter and 83 per cent in toxic adenoma.

The advantages of the roentgen method of treatment are (1) its freedom from danger, (2) its ease of application with a minimum of inconvenience and loss of time to the patient, (3) its availability in inoperable and postoperative cases.

We will conclude by stating briefly what we consider the essential points in the general management and treatment of a patient with hyperthyroidism:

A complete history is obtained and a thorough physical examination made. If a provisional diagnosis of hyperthyroidism is justified, the basal metabolic rate is determined. Inquiry is made with regard to living conditions, occupation, etc., and decision made as to whether the occupation may be continued or whether the patient should rest at home or in the hospital for a time. Careful instructions are given about the diet and amount of exercise to be taken. Sources of focal infection are sought and if the patient's general condition permits, they are removed.

Roentgen treatment is given over each lobe of the thyroid and over one area over the thymus region. We have not yet followed Pfahler's suggestion to cover the larynx, but have had two cases of troublesome hoarseness following treatment and think it would be well to use this precaution. The following are the essentials of our technique: 5 ma., at a 9-in. gap for six minutes over each area at 8-in. distance through 5 mm. of aluminum. Three successive doses are given at three-week intervals. The basal metabolic rate is again determined about three weeks after the third treatment. In a few cases no further treatment is necessary, but usually the rate is still somewhat elevated, and a fourth treatment is given at the usual three-week interval. Thereafter treatment is given at monthly intervals until two, or at the most, three more have been given. The necessity for these additional treatments is carefully considered in the light of the general condition of the patient and the basal metabolic rate.

We have treated 114 cases of hyperthyroidism and sufficient time has elapsed to state that 32 of these cases are cured, as indicated by their clinical condition and continued normal basal metabolic rate. Three patients have died: one of influenza, one of pulmonary tuberculosis, and one of hyperthyroidism. Four cases have been operated upon after roentgen treatment, but in only one of these was the roentgen treatment given sufficient trial. Six of our cases had had previous lobectomies or thyroidectomies. Two of these postoperative cases have returned to their work apparently well; one had permanent cardiovascular and visceral changes and is probably a permanent invalid, but her hyperthyroidism has subsided; the other three are recent ones and are doing well under treatment.

Twenty-four cases are greatly improved and will probably need no further treatment.

Three cases are clinically well, but after eighteen months or more they continue to have a somewhat elevated basal metabolic rate—from plus 22 to plus 28 per cent. We are urging further treatment in these cases, but have not yet convinced them that it is necessary.

In one case we have given a second series of three treatments because of moderate return of symptoms. This was followed by their prompt disappearance.

The results have, on the whole, been satisfactory, especially when we consider the fact that a number of these cases were of very severe type with basal metabolic rates above plus 100 per cent, some quite inoperable, and others operative failures.

SUMMARY

1. Comparison of the results obtained in treatment of hyperthyroidism by surgery and the roentgen ray indicates that these two methods are probably about equal in the percentage of permanent cures.
2. Patients with hyperthyroidism should first receive roentgen treatment, and have thyroidectomy only if they fail to respond to this treatment.
3. The general management of patients with hyperthyroidism is of prime importance whether the ultimate treatment is to be the roentgen ray or surgery.

BIBLIOGRAPHY

1. Pemberton, J. deJ. The surgical management of toxic goiters. *Boston M. & S. J.*, 1922, clxxxvi, 244–254.
2. Crile, Geo. W. The Thyroid Gland. Philadelphia, 1922.
3. Judd, E. S. Results of operations for adenoma with hyperthyroidism and for exophthalmic goiter. *Ann. Surg.*, 1920, lxxii, 145–151.
4. Pfahler, Geo. E., and Zulick, J. D. The treatment of exophthalmic goiter (Basedow's or Graves' disease). Am. J. Roentgenol., 1916, iii, 63.
5. Pfahler, Geo. E. Treatment of hyperthyroidism by radiation. *Med. Clin. N. A.*, Nov., 1921, v, 853.
6. Hertzler, Arthur E. Diseases of the Thyroid Gland. St. Louis, 1922.
7. Jones, H. M. Control of *x*-ray therapy in hyperthyroidism by basal metabolic test. *J. Radiol.*, Mch., 1922, iii, 85–92.
8. Boothby, Walter M. Adenoma of the thyroid with hyperthyroidism (thyrotoxic adenoma). History of the recognition of this disease as a clinical entity. A study of the symptomatology with basal metabolic rates. *Endocrinology*, 1921, v, 1–20.
9. Boothby, Walter M. The basal metabolic rate in hyperthyroidism. *J. Am. M. Assn.*, 1921, lxxvii, 252–255.
10. Deaver, John B. Hyperthyroidism from surgical point of view. *N. York M. J.*, Feb. 12, 1921, cxiii, 265.
11. Halsted, William S. The operative story of goiter. *Johns Hopkins Hosp. Rep.*, 1919, xix, Fasc. 2.
12. Kendall, Edward C. Some physiologic and chemical properties of thyroxin. Mayo Clinic, vol. xiii, Philadelphia, 1921.
13. Lichty, John A. Treatment of diseases of the thyroid with special reference to so-called hyperthyroidism. Am. J. Roentgenol., Dec., 1919, vi, 608.
14. Mayo, C. H. Adenoma with hyperthyroidism. *Ann. Surg.*, Aug., 1920, lxxii, 134.
15. Mayo, C. H. The thyroid and its diseases. *Surg., Gynec. & Obst.*, 1921, xxxii, 209–213.
16. McGuire, Stuart. Basal metabolism as an aid in diagnosis, prognosis, and treatment of hyperthyroidism. *J. South. Car. M. Assn.*, May, 1920, xvi, 107.
17. Means, J. H., and Aub, J. C. Basal metabolism in hyperthyroidism. *Arch. Int. Med.*, Oct., 1919, xxiv, 404.
18. Means, J. H. Hyperthyroidism—toxic goiter. *Med. Clin. N. Amer.*, Jan., 1920, iii, 1077.
19. Plummer, Henry S. The interrelationship of the function of the thyroid gland and of its active agent, thyroxin, in the tissues of the body. *J. Am. M. Assn.*, 1921, lxxvii, 243–247.
20. Sturgis, C. C., and Tompkins, E. H. Study of correlation of basal metabolism and pulse rate in patients with hyperthyroidism. *Arch. Int. Med.*, Oct., 1920, xxvi, 467.
21. Tyler, A. F. Roentgenotherapy of the thyroid. Am. J. Roentgenol., Jan., 1922, ix, 25.

DISCUSSION

Dr. Pfahler. I can confirm everything Dr. Christie has said in his paper. I have treated about 200 cases. Three were operated on, and I am not willing to admit that they had to be operated on. In fact, I think they did not. One of these 3 cases was operated on because the patient was in the hospital and it meant too long a stay in the hospital to wait for cure by the *x*-rays. The other 2 cases were not willing to wait for results and were operated on. One patient developed recurrence which could not be controlled, and the patient died. Another patient, a very acute case, showed no response and died about a month after beginning treatment. That patient, however, was inoperable from the beginning.

I would urge the importance of covering up the arytenoid cartilage of the larynx. In that way you will prevent some of these disagreeable attacks of hoarseness which sometimes develop.

The technique which Dr. Whidman and I have been using is very similar to the one described by Dr. Christie. We usually treat through four areas: one, having the patient lie on back, dividing into median line, sending dose across from left side directed downward so as to catch the thymus, and likewise from the opposite side; then turning patient on face and giving two doses from behind, also directed downward. That enables us to reach the deeper portions of the gland. We usually begin with 12-min. exposure at 10-in. distance, 6 mm. filter, 5 ma., 9-in. spark-gap. After the first exposure we usually reduce the time to 10 min. We have not treated any with the high voltage, and I do not think we will. The results are so uniformly satisfactory to everyone that we have no reason to change, and the fact that the number of patients is continually increasing and that patients are constantly referring new ones, shows that the work is probably based on a solid foundation.

As I say, there have been only one recurrence and two deaths out of approximately 200 cases, and in the case of one of these deaths the patient could not be operated on. Therefore, we can bear out the statement made by Dr. Christie that there is no mortality from the treatment itself.

Dr. Dunham. I wish to add my appreciation of this magnificent paper of Dr. Christie.

There is only one point on which I would take issue, and that is the time of stopping treatment. He wants to stop after five or six treatments. Personally, I do not think that is enough. I know my failures would have been numerous had I followed that regime.

The point I wish to bring to your attention is that as *x*-ray men giving a new treatment we have been too much on the defensive. We have listened very keenly and properly for a long time to the criticisms of the surgeon, but *x*-ray treatment of hyperthyroidism has reached the point where we do not have to apologize; when we can stand and say that many more cases have to be treated by *x*-ray after operation than have to be operated on after *x*-ray treatment.

I have had 2 cases operated upon since 1903 by surgeons. They absolutely were taken away from me by the surgeon who told them that if they had another treatment, he would not think of operating.

I do not know the malignant thyroids. I cannot tell you how many patients might have had this, except for the treatment, or how soon I am going to have such a case in spite of the treatment, but I have had no such case.

What I have had is cases that have become temporarily insane—they went all to pieces. One had to be confined, but that case improved and got better, the tumor, tremor and exophthalmus almost disappearing. He is so much better that his physician advises against further *x*-ray as well as operation. He is not cured. Fortunately, none of my cases so far have died. There is a long series over a long time that have become practical cures. The cases which have followed my advice represent what I estimate as 100 per cent cures.

Two cases have gotten away from me because they were stolen—not because they had any right to go, not because I sent them to the surgeon, and not because they particularly wanted to go. It was because they were frightened into going, and that in itself is a crime. Cases of toxic goiter should never be frightened. Rest and everything else is a small matter compared to the avoidance of fright in a patient suffering from hyperthyroidism. Scare them, and the basal metabolic rate shoots up in an alarming manner.

Another thing I want to call to your attention. That is that you should not accept young girls for treatment who have just a little enlargement of the thyroid and rapid pulse. These symptoms become adjusted in a little while, and they do not need *x*-ray treatment or surgery. There are a number of such cases being operated on today by our surgeons, and I want to say to you that I believe the surgical attitude is something we ought to look into and resent.

The basal metabolic rate is one of the most valuable tests we have—that and the pulse. Plummer has called to our attention the cycles through which these cases pass—better; worse; better; worse. At one time you get a basal metabolic rate which is way down and you think the case does not need more treatment, and in a week or ten days it goes up again. So watch the phase of the cycle in which you examine your patient. That patient requires not only the management of which Dr. Christie speaks, but also the strength of your personality and assurance from the time that you take charge of the case until treatment is complete. Encourage your patient, and have him come back to you the very moment he is discouraged, even if it is not time for another treatment.

The treatment of exophthalmic goiter and hyperthyroidism by the *x*-ray is as marvelous as anything I know, next to the treatment of carbuncles, and I believe that no case should be operated upon.

Dr. Gray. I think this paper, if published in the Southern Medical Association Journal, will be the most valuable of any article ever published by that Journal; that is, so far as roentgenology is concerned.

I can see in this paper the processes that took place in the mind of Dr. Groover, who was chairman of the Radiological Section of the Southern Medical which met in Chattanooga last November. We had a joint meeting of the radiologists and the surgeons. Dr. George Holmes was scheduled to hold up the side of radiotherapy in the treatment of the thyroid, and Dr. Crile, the surgical side. Dr. Crile opened the discussion. After describing his procedure and stating the results, he threw on the screen a chart of 1,000 operations for hyperthyroidism; 500 were thyroidectomies and 500 were ligations, with a mortality of 5/10 of 1 per cent about evenly distributed between the two.

He apologized for the next slide he showed and stated that he did not show it for the appearance of the skin but in illustration of the fact that *x*-ray made a thyroidectomy much more difficult. It happened, however, that the slide he showed was a typical exophthalmic goiter with bulging eyes, etc., but the skin below the neck, (well below the thyroid) extending to the middle of the chest had been terribly burned. The next slide was similar.

These were illustrations of the difficulty surgeons experienced in operating on thyroid glands after *x*-radiation, *but not for the purpose of showing any bad effects on the skin.*

The vast majority of the audience were surgeons. Dr. Holmes came on with his usual modest manner and gave the results of the investigations of the Thyroid Commission of the Massachusetts General Hospital.

Nobody was allowed to ask Dr. Crile how many of the cases which he had operated on had come to *x*-ray treatment afterwards. In my own experience I have had many more post-thyroidectomy cases to treat than I have had go from me to the surgeon.

I think I was one of the earlier men to treat hyperthyroidism; and in Dr. Pfahler's report there are several cases that I treated before we began filtration. I do not know how many cases I have cured permanently. I began the treatment back in the early days.

My trouble is that the patient is referred to me by a surgeon perhaps because some pressure has been brought to bear upon him for some other treatment than surgery. The patient is his, not mine, and I am serving under him in a way, and if improvement is not as he thinks it should be, he takes the patient and operates.

I have had some cases that I myself thought were very much better for operation than for radiation.

My technique is almost identical with that of Dr. Christie, except for a little difference in distance; I work at 10 inches and give a little more time.

I have in mind one of the best results I have ever obtained—a young woman of about thirty-eight years of age, who had had a lobectomy. She was temporarily relieved, but a recurrence took place and she was the most miserable individual I have ever seen; she had little or no exophthalmos but was very nervous; in fact, there was a question of sending her to an asylum. When she came to the office she could not endure having a light protection shield touch her face. About six treatments have gotten that young woman into the condition that enabled her to say to me just two weeks ago that she thought her life had been absolutely saved, as well as her mentality, by the treatment I had given her.

Dr. Christie (closing discussion). I would like to mention a point spoken of by Dr. Dunham. I over-emphasized in my paper that we tried to stop at about the fourth treatment. We do not always stop at four treatments, but that is one of the great advantages of having general observation of your patient. If you will watch your patient with great care and have a basal metabolic rate done often enough, and watch the pulse and weight, you can afford to wait a little while. It is just at this time, about the fourth treatment, that we are likely to be most discouraged in the treatment of this disease. If we wait, we will find the patient improved and then it is not necessary to give treatments so often. If we persist in giving numerous treatments, we will get the skin changes that come with the treatments, and if it happens that the case finally does go to operation, then we get fibrosis, etc. We must admit that, I think.

The most important point to be emphasized is that the general management of cases must come home to us, and we must take our cases in charge and actually treat them ourselves, or at least see that they get proper general management; that we do not permit the internist to send them for a dose of *x*-ray, and ignore them afterwards. We are apt to have a great many failures and bring *x*-ray into disrepute by such means.

PROTECTIVE FACTORS IN MODERN HIGHLINE X-RAY WORK

BY ALBERT SOILAND, M.D.

LOS ANGELES, CALIFORNIA

THE incentive for American participation in high voltage *x*-ray work came from Europe where, during the late war, intensive studies were undertaken along this line. Among achievements of those who have contributed to this literature, Dessauer's work may be alluded to. He has built up ample transformers, and from these has measured wave-lengths, computed intensities, plotted absorption curves, and calibrated various filters. He has also described fully the biological reactions with varying intensities up to the capacity limit of his apparatus. The result of four years' clinical work abroad with similar transformers has been highly stimulating to many medical men and is, in a large measure, responsible for the active interest now being taken in broadcasting this work in America.

Following established custom, the American scientist was not satisfied with the voltage obtained by his European confreres, so he immediately bent his energies to furnish us with apparatus which materially increases the volt ratio over that used abroad; in fact, the voltage obtained is even higher than that which can be accommodated by the present types of hot cathode tubes.

The next factor, then, which engineering skill must face is to produce successfully tubes which will enable us to use the available high line. Voltages over 200,000, owing to the line stress, have the awkward habit of producing electrodynamic surges from occasional high peaks, acting very much like cross seas in a heavy swell, the usual result being a punctured tube.

The subject of high voltage *x*-radiation is already assuming such magnification that, in a single short contribution, only a few fundamental facts can be considered. The evolution of this new therapy will have to be followed slowly, carefully and with infinite patience. It will take years before one can be at all sure of the physiological responses, delayed reactions, and terminal effects. Our greatest efforts should be directed toward a standardization of procedure, so that a compendium of reliable data may in time be available.

One of the outstanding factors in radiology today is the problem of adequate protection, not only from the energy of radiation, but also from the high potential electrical current. This latter takes on added importance when it is applied to the installation of apparatus that requires a voltage of 200,000 or more, for its operation. To protect securely both patient and operator from any danger of contact with this line is a problem of no small proportions. Especially is this matter pertinent owing to the multiplication of high voltage installations now going on in all parts of the world. It is true that death has not been frequent from contact with one side of the line carrying energy to the universal type of tubes, running all voltages not in excess of 100,000, although you will recall that there have been deaths from such contact. It is when this voltage is more than doubled that the question assumes a sinister aspect, and this is the situation which you and I will be called upon to meet and conquer. One also must fully realize his personal obligation to humanity when creating, by means of higher voltages, an energy as yet unmeasured, both qualitatively and quantitatively; an energy termed by the writer "super-radiation," our knowledge of which is at present pitifully elementary. We do know, however, that a single vacuum tube, under such stimulus, is capable of projecting an enormous volume of *x*-radiation very closely related in ethereal form to the gamma radiation from radium.

Today, modern engineering skill has produced for us apparatus which with mechanical certainty will generate radiation energy practically unlimited in range and scope. The apparatus is so constructed and assembled that, by merely turning a switch, this unseen and insensible energy may be dispersed through space, there either to renew or destroy life, according to the operator's ability to control the forces at his command. Knowing this, it is paradoxical that there is in this country no specific law to prevent any person, irresponsible or otherwise, who has sufficient funds with which to purchase such an apparatus, from using the same indiscriminately. It is, therefore, imperative that we who are vitally interested in this work should protect it from all hazards to the best of our scientific and personal ability.

The transformer which energizes an *x*-ray tube for deep treatment has a potential force which varies from two to three hundred kilovolts. To come into contact with any part of this high line would mean, almost invariably, sudden death. This takes on a more somber meaning when applied to many of the present-day high tension installations which are so mounted that a patient under treatment can, by a careless movement, come into actual contact with the line at several points.

The employment of high voltage *x*-rays in routine work brings with it a twofold responsibility. In the first place, both the patient and the operator must be shielded from the effects of the more powerful *x*-rays we are now employing, and secondly, all possible opportunity must be excluded for either patient or operator coming into contact with the high voltage line.

Preventing the wandering of stray rays and confining the radiation to the desired path is relatively simple; but it requires lead, in fact a great deal of lead. To obtain adequate metallic protection equivalent to ¼ in. lead, and to allow space for operating up to 300,000 volts requires about 1,000 lbs. per tube.

Protecting the patient or operator from the high tension line can only be accomplished with perfect safety in one way. The high tension wires must clear all objects by an air space equivalent to ½ more than the full sparking voltage, and a grounded conducting shield must intervene between the wiring and all persons who may approach it.

This is exceptionally true of the writer's installation where auto-transformer control is used on the high voltage apparatus, and no resistance whatever is included in the circuit. This arrangement has made it possible to maintain effective standardized operation, and several tubes may be run at once from the same apparatus without appreciable line fluctuation, but it makes necessary an even greater attention to safety, as the power of an electrical shock from this equipment is almost beyond calculation.

To meet the condition of full *x*-ray protection from any high voltage operation, so much lead is required that it appears to the writer impractical to attempt a mobile tube unit; therefore, the patient is moved and the tube mounted stationary.

A happy combination of high voltage and *x*-ray protection has been devised by placing the tube under a bridge deck and liberally surrounding it with lead. The rays are emitted upward through a variable orifice and, through suitable filters, reach the patient. There is also a diaphragm opening provided in the front face of the deck, through which, by simply rotating the tube, the stream may be directed to a patient who is in the sitting posture. It is advisable, however, to make use of this portal only when absolutely necessary in order to avoid pointing the ray beams toward the operator or observer. It is, of course, possible to protect against this contingency also, but it adds to the existing complications.

It will be found that nearly all conditions can be met successfully by placing a movable couch, which supports the patient, above the tube. This gives a constant skin target distance. A small plumb bob suspended from a swinging bracket above the patient serves to locate the focal point of the tube, and the couch can be readily moved until the area desired is in juxtaposition with the central ray.

Not the least important in this whole arrangement is the total freedom of movement permitted both patient and operator, there being no possible chance of a contact with any part of the high line. In addition, the tube is suspended in a spacious chamber connected with outside air and completely insulated from operating room. This obviates the necessity of fans, and prevents any of the noxious oxides or other electrical adjuvants from reaching the patient; a point to be remembered when thinking of the usual position of the patient lying under an ordinary overhead installation, particularly of the heavy and complicated varieties.

In the writer's laboratory, tubes are working at a potential pressure of 220,000, measured and checked by the engineers' standard sphere gap device for effective voltage, in addition to the available penetrometers, iontoquantimeters and similar instruments. It is possibly needless to say that the most painstaking care is exercised when employing this voltage under working conditions. In addition to a personal attendant at the board, we employ a reliable time-switch arrangement connected with two loud-toned gongs which automatically strike when the treatment period is concluded. The reason for having two such gongs is merely in case one should mechanically fail to operate.

Another important factor we employ is a reliable magnetic circuit-breaker. This may be adjusted so as to break contact the moment any unexpected surge or high peak wave develops. This circuit-breaker may not only save one from physical injury, but also obviates the necessity of replacing costly tubes and broken-down transformers.

Much profitable time could be spent on an elaboration of many of these factors, but as you are all familiar with most of the protective and safety devices which enter into the installation and operation of a modern plant for deep roentgen therapy, it will be omitted.

It is much too early to state positively what we may expect in deep malignancies, and sufficient time has not yet elapsed to enable us to obtain enough cases for final determination. Conservatively, it may be stated that from present indications we have more than mere theoretical grounds for optimism. If, in the course of this preliminary presentation, you have realized that the subject under discussion merits not only your respect, but also your unqualified interest and support, then a scientific future for deep roentgen therapy may be confidently expected.

THE BACTERIOLOGY OF IRRADIATED TONSILS*

BY H. J. ULLMANN, M.D., AND F. R. NUZUM, M.D.

Santa Barbara Cottage Hospital,

SANTA BARBARA, CALIFORNIA

In 1920 Murphy[1] reported tonsils free of hemolytic cocci three weeks after exposure to the roentgen ray. In all cases either hemolytic streptococci or staphylococci had been originally found. The cultures were made from the crypts and grown on blood-agar. Later, in 1921, he and Witherbee[2,3] reported that the common organisms found in the throat were unaffected by roentgen irradiation, but 30 of 36 cases showing hemolytic streptococci and staphylococci became free from these organisms by the fourth week after treatment. Price[4] states that the roentgen ray disinfects tonsillar tissue. Hickey[5] reports fifteen cures in 19 cases of diphtheria carriers.

In bacteriologic studies of infected tonsils, streptococci have assumed more prominence than other organisms. Further work which has divided streptococci into hemolytic and non-hemolytic varieties has demonstrated that the hemolytic organisms are the virulent ones and the ones associated with clinical conditions.

The most complete classification for streptococci is that of Holman,[6] which divides these organisms into sixteen groups, eight of which are hemolytic and eight non-hemolytic. We have, however, followed a less elaborate but very practical classification, that of T. Smith and J. H. Brown,[7] which divides all streptococci into four groups, depending upon their manner of growth in blood-agar plates. Alpha hemolytic streptococci are characterized by a small zone of brown or green discoloration immediately about the colony.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922.

Alpha prime hemolytic streptococci have immediately about the colony a small area of incompletely hemolyzed red blood-cells. Beyond this is a ring of complete hemolysis. Beta hemolytic streptococci is that group which has a zone of complete hemolysis immediately about the colony. This clear zone varies from 1 to 4 mm. in width. The fourth, or final division of streptococci, is the non-hemolytic colonies. They appear as small, dark dots, and produce no change in the adjacent corpuscles of the media.

Technique. Our procedure in cultivating the tonsils was as follows: A sterile swab was drawn across the tonsillar surface and then placed in 1 c.c. of sterile physiologic salt solution. A platinum loop bent at a right angle near its distal end was introduced into a crypt, withdrawn, and dipped into a second tube containing 1 c.c. of sterile physiologic salt solution. A few drops of each of these inoculated solutions were poured into Petri dishes and 12 c.c. of liquid blood-agar added. The Petri dishes were gently agitated until the salt solution had become well mixed with the blood-agar and then put aside to cool, after which they were incubated for forty-eight hours. Streaked blood-agar plates were made from the same material and incubated. The plates were read at the end of twenty-four and forty-eight hours. Bile solubility and the various sugar media were employed in making a final classification of doubtful colonies.

Results. In a series of 218 pairs of pathologic tonsils that had been removed and examined by the above method, one of us (Nuzum)[8] found hemolytic organisms in 96.1 per cent. Of the hemolytic organisms, beta streptococci were present in 86.1 per cent; alpha in 25 per cent; and alpha prime, or streptococci viridans, in 32 per cent. This is in agreement with recent findings of Davis[9] and of Pilot and Pearlman.[10]

Because of the clinical importance of these organisms and the frequently reported clinical benefits resulting from irradiation of tonsils, the authors have attempted to determine whether the results of radiation of tonsillar flora were not more or less selective and affecting principally the pathogens, and if so, in what percentage could bacteriologic results be expected. The number of cases studied is too small to draw any hard and fast conclusions, and therefore this paper is intended to be in the nature of a preliminary report.

Forty patients said clinically to have infected tonsils have been studied. Prior to irradiation, beta hemolytic streptococci were isolated in each instance. Seventy-five per cent had alpha organisms, and 80 per cent had alpha prime organisms. Non-hemolytic or gamma streptococci were found in 40 per cent of the instances. The explanation for all types being found in nearly every case is that many cultures were made from time to time, and during the course of cultures the various organisms were found.

Of the 40 patients studied in this preliminary manner, all of whom received treatment, 20, or 50 per cent, for various reasons did not receive enough treatment to warrant making a final decision as to the effect of the roentgen ray upon the bacterial flora. Twenty did receive what was considered sufficient treatment. In 20 per cent of this number, marked gross change occurred in the tonsils. In each instance this consisted in the marked shrinking of the tonsil; the crypts became everted and shallow; the mucous membrane covering the tonsil pale gray and smooth; and the cultures from these tonsils became negative for all types of streptococci. In addition to the tonsils which underwent marked gross change, a further group of 35 per cent became negative for beta hemolytic streptococci. These tonsils remained free from these organisms up to six months following the last treatment. None have been cultured for a longer time than that. In several instances the tonsils did not become immediately free from beta organisms, even for so long as one month after the last treatment, but when the patients were cultured at the end of six months they were found to be free. The remaining 45 per cent of the patients in this group presented no marked gross change in the tonsils, and no change occurred in the bacterial flora. Beta hemolytic organisms were present in every instance and alpha and alpha prime organisms were frequently found.

The technique, with the exception of 6 cases, was that recommended by Witherbee. With these 6 the technique was as follows: K.V.P., 200; F.S.D., 50 cm.; port 9 cm. sq.; filter, Cu 1 mm., Al 1 mm.; ma. min., first sitting, 25; second sitting, 35; third and fourth sittings, 50. Forty-eight hours elapsed between the sittings. One patient received two series with an interval of three months, the first with the Witherbee technique, the second with the one described above. In these 6 cases the results were exactly 50 per cent successful. One of the unsuccessful cases was that of the patient who had had the two series.

No relation between the clinical and bacteriological results was observed. Some, whose throats had become free of streptococci, said that they could see no difference in the condition of their throats following treatment. Others, who still harbored pathogens, were highly pleased with the results. The most interesting of these was the patient who had received two series. She states that a tonsillitis had always followed or accompanied any acute infection of the upper air passages, but that following radiation she has had several more or less severe "colds" without tonsillar involvement. This in spite of our failure to obtain results from a bacteriological standpoint. It would seem that some other explanation than that of sterilization must be found for the clinical benefits observed in the treatment of infected tonsils by the roentgen ray.

SUMMARY

Of 20 cases receiving roentgen irradiation of the tonsils, 20 per cent underwent a marked gross change, became much smaller, and remained free from beta hemolytic streptococci. An additional 35 per cent became free from beta hemolytic streptococci and remained so for six months after treatment. Forty-five per cent still harbored these organisms following the entire series of exposures. No difference in results was seen between those treated by the Witherbee technique and those treated by the technique described, and no relation between clinical and bacteriological results was observed. The series reported is too small to draw conclusions from, and it is hoped that a larger series will be available in the near future.

BIBLIOGRAPHY

1. Murphy, James B. Effect of small doses of roentgen-ray on lymphoid deposits. *J. Am. M. Assn.*, June 19, 1920, lxxiv, 1738.
2. Murphy, James B., Witherbee, W. D., Craig, S. L., Hussey, R. G., and Sturm, Ernest. *J. Am. M. Assn.*, Jan. 22, 1921, lxxvi, 228.
3. Witherbee, W. D. The principles involved in the *x*-ray treatment of tonsils. *N. York Med. J.*, March 16, 1921, cxiii, 484.
4. Price, Byron Sprague. Treatment of adenoids and tonsils by *x*-ray vs. surgery. *Am. J. Electrotherap. & Radiol.*, Feb., 1921, xxxix, 81.
5. Hickey, P. M. Treatment of diphtheria carriers by means of roentgen ray. Am. J. Roentgenol., May, 1922, ix, 319–322.
6. Holman, W. L. Classification of streptococci. *J. Med. Research*, 1916, xxviii, p. 337.
7. Smith, T., and Brown, J. H. A study of streptococci isolated from certain presumably milk-born epidemics of tonsillitis occurring in Massachusetts in 1913 and 1914. *J. Med. Research*, 1915, xxxi, 445.
8. Hambrecht, L., and Nuzum, F. R. A correlated study of the indications for tonsillectomy and of the pathology and bacteriology of excised tonsils. *Arch. Int. Med.*, 1922, xxix, 635–642.
9. Davis, D. J. Hemolytic streptococci. *J. Am. M. Assn.*, Feb. 1, 1919, lxxii, 319.
10. Pilot, I., and Pearlman, S. J. Bacteriologic studies of the upper respiratory passages. *J. Infect. Dis.*, 1921, xxix, 47.

DISCUSSION

Dr. Remer. I was very glad to hear Dr. Ullman say that often within a month you still find microorganism, and that it is frequently a month or two before those microorganisms have disappeared.

Dr. Ullman (closing discussion). The point that we are trying to bring out evidently is that while there is a difference in the susceptibility of the various organisms to radiation, the results obtained are more apparent than real. We have found in culturing that perhaps they will be sterile or nearly sterile for pathogens in early cultures, then clear again, then become sterile again. We have had some become sterile immediately, then become infected again. Before this can be answered I think we should take cultures of most of them that have been radiated every week or two for six months and see if there is not a normal curve. There is less bacteria at one time than at another. If the pathogens are more susceptible, then the patients who have received marked benefit should have fewer of those pathogens. There is no relation between the clinical results; some who are benefited still have pathogens, and vice versa.

MEASUREMENT OF DOSAGE BY MEANS OF IONIZATION CHAMBERS*

BY WILLIAM DUANE, PH.D., SC.D.

Professor of Biophysics, Harvard University

BOSTON, MASSACHUSETTS

THE fact that different *x*-ray plants produce *x*-rays of different intensities and effective wave-lengths even though they may be running at the same voltage, as estimated by a sphere-gap, and with the same current through the tube, indicates that we must use a method of measuring something connected with the *x*-ray beam itself, if we wish to get reliable estimates of dosage.

Variations of 40 per cent and more in the intensity of the *x*-rays projected through the same filter and at the same distance from the tube with different machines are not uncommon, and in extreme cases one machine may produce twice as much *x*-radiation as another.

Without doubt, ionization chambers provide us with the most reliable methods of measurement, at present. Ionization chambers, however, are by no means perfect, and great care must be exercised in employing them.

I purpose, in this discussion, to describe the method we are using and to call attention to certain pitfalls into which one is apt to stumble, hoping that this may prove of use to those of you who are using ionization chambers, or who may be planning to purchase them.

When a beam of *x*-rays passes through a gas, such as air, it splits up the molecules of a gas into particles (called ions), some of which carry a positive charge of electricity, and others a negative charge. If left alone, these particles will recombine with each other, owing to the attraction of those charged positively for those charged negatively. By applying an electric force to the ionized gas, however, we can separate the positively charged particles from the negatively charged ones. For instance, suppose that the ionized air lies between two parallel metal plates, one of which is connected to the positive pole of a battery and the other to the negative pole. Under these conditions the positively charged plate attracts the negatively charged ions and draws them to it out of the air; similarly, the negatively charged plate attracts the positively charged ions and pulls them out of the air in the opposite direction. Thus, the battery produces a current of positive electricity through the air in one direction and a current of negative electricity through the air in the opposite direction. This current may be measured by a galvanometer suitably placed in the electrical circuit. We may use the electrical current as measured by the galvanometer as an indication of the intensity of the *x*-ray beam, for, in general, a strong beam of *x*-rays produces a larger number of pairs of ions than does a weak one.

The electrical current, as measured by the galvanometer, however, will not give reliable estimates of the intensities of *x*-ray beams unless in each case the electrical force acting on the ions suffices to remove practically all of them before they have time to recombine with each other. For example, if two equal and similar beams of *x*-rays pass through the air between the plates, the current will not be twice as great as that due to one beam alone, if an appreciable number of ions recombine with each other before they reach the plates; for with the two beams passing through the air, twice as many pairs of ions are produced per second as with one, and there is a much greater chance for the ions to recombine with each other. Those ions which recombine cease to produce their share of the electrical current. If, however, the electromotive force of the battery produces an electrical force on the ions of sufficient magnitude to remove practically all of them before they have time to recombine, then the electrical current due to two equal, similar beams of *x*-rays will be twice as great as that due to one of them alone. In this case we may take the currents as proportional to the intensities of *x*-ray beams.

---

*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

Discussion on this article will appear in June.

If the electric force acting on the ions suffices to remove practically all of them before they can recombine, the ionization current is said to be saturated. Only saturated ionization currents should be used to measure *x*-ray beams.

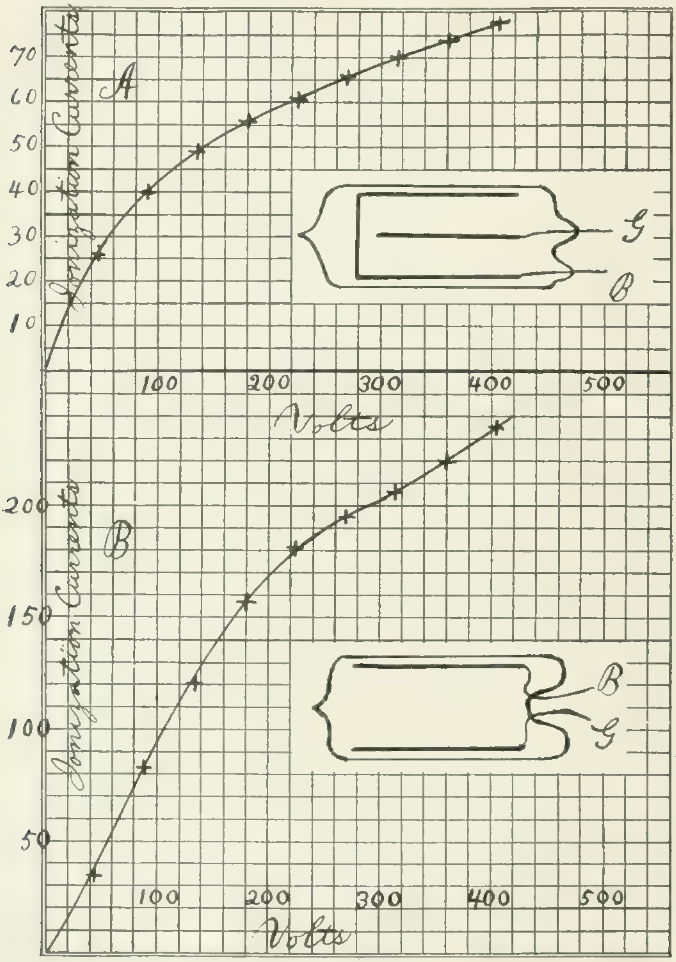


Fig. 1.

In some ionization chambers great difficulty may be encountered in producing the saturated current; in other cases, a small battery may produce such saturation. I will illustrate these points by describing several experiments, in some of which I could easily produce a saturation current and in others of which the batteries at my disposal were not sufficient to saturate the current.

The diagram in A (Fig. 1) represents a hollow, metal cylinder, closed at one end, with a rod lying along the axis of the cylinder, the cylinder being joined to a battery and the rod to a galvanometer, and the other pole of the battery being connected to the galvanometer so as to form a complete electrical circuit. The cylinder and rod lie in a closed, glass vessel, as indicated.

On sending a beam of *x*-rays through this ionization chamber and on changing the number of cells in the battery, that is, on changing the voltage applied to the cylinder, a number of different currents through the chamber were obtained. The curve in A (Fig. 1) gives the readings of the galvanometer at different voltages applied to the cylinder.

It appears that on increasing the number of cells in the battery, that is, on increasing the voltage applied to the cylinder, the ionization current, as measured by the galvanometer, keeps on increasing and does not reach a constant value. This means that, as the electrical force acting on the ions increases, more and more of the positive ions become separated from the negative ions before they have time to recombine. In this case, however, the electrical force applied was never sufficient to remove practically all of the ions before they could recombine with each other. In other words, a saturation current was not produced. An ionization chamber with these characteristics should not be used to measure *x*-ray beams. Cylindrical ionization chambers of this type should never be used, if the wire along the axis of the cylinder is very fine.

B (Fig. 1) represents an ionization chamber in which both electrodes are metal plates, one of them joined to the battery and the other to the galvanometer, as above. In this case, on increasing the voltage applied to the plates the curve in B was obtained. This curve also indicates lack of saturation; for the ionization current continues to increase as the size of the battery increases. In this chamber the metal plates did not cover the entire sides of the glass vessel containing them and left corners in the vessel from which the electric force was unable to withdraw all of the ions. The design of this chamber illustrates again a kind of ionization chamber that should not be used.

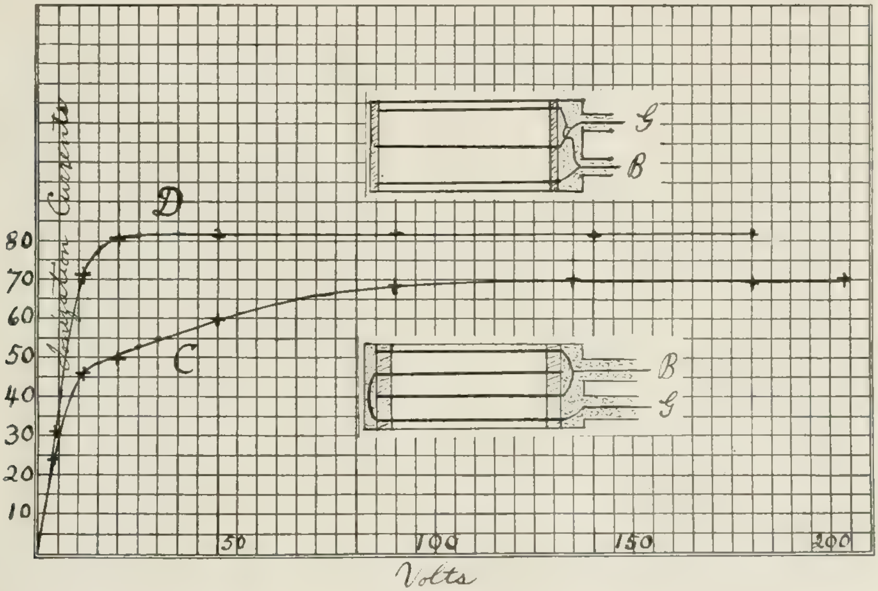


Fig. 2.

C in Figure 2 represents a chamber in which the parallel metal plates extended to the ends of the closed space, enclosing the air. They did not, however, extend to the sides of this enclosed space in a direction perpendicular to the diagram. Further, one of the plates joined, as indicated, to the galvanometer lay close to the metal sheet wrapped around the chamber for protection. The curve giving the current produced by different voltages indicates a much closer approach to saturation in this case than in the two preceding cases. In other words, the design of the chamber is better than those of the first two.

It is not quite as good, however, as that represented by D (Fig. 2) in which all three plates extend completely across the enclosed air. In this chamber the two outside plates go to the battery and the inside one to the galvanometer. The curve D (Fig. 2) indicates practically complete saturation by voltages above 20 volts. For saturation purposes this chamber represents the best type that I have examined. It is the one we are now using in our measurements of the intensities and effective wave-lengths of *x*-ray beams.

As indicated above, the question of saturating the ionization current becomes one of prime importance. No chamber should be used or purchased unless it has been proved experimentally that the electric force produces saturation.

If saturation currents are not obtained, the readings of the galvanometer do not give reliable measurements of *x*-ray beams. Intense beams will produce relatively smaller deflections than they should, and, vice versa, weak beams of *x*-rays will produce relatively too large deflections. Perhaps some of the exceptionally high depth dose readings obtained by certain observers may be due to the fact that they were not using completely saturated ionization currents.

In order that we may compare with each other measurements made in different laboratories and in different clinics it is desirable to have some standard unit of x-radiation and some standard method of measurement. The unit that I have been using for the last nine or ten years may be defined as: "That x-ray beam which would produce one absolute electrostatic unit of current in each cubic centimeter of air through which it passes, provided that the current has its saturation value."

Ionization chamber D (Fig. 2) does not appear to be suitable for measuring currents in terms of this unit, for two reasons. Firstly, a large part of the ionization arises from the secondary rays produced by the primary beam of x-rays in the plates and walls of the chamber. The secondary rays increase the ionization current and the readings of the galvanometer become, therefore, too high. This secondary ray effect may be greatly reduced by using some substance of low atomic weight in place of the metal plates. In the measurements of effective wave-lengths recorded in an article by Dr. Hunt and myself[1] we used sheets of thin paper with faint pencil-marks drawn across them. The plates, therefore, were very thin layers of carbon. A much better method, however, is that which I have previously employed to standardize the ionization chamber that we actually used. In this method I compared the current produced in the chamber to be standardized with that produced by the same beam of x-rays in a chamber so designed that the x-ray beam did not strike anything inside the chamber. Figure 3 represents one of these standard ionization chambers.

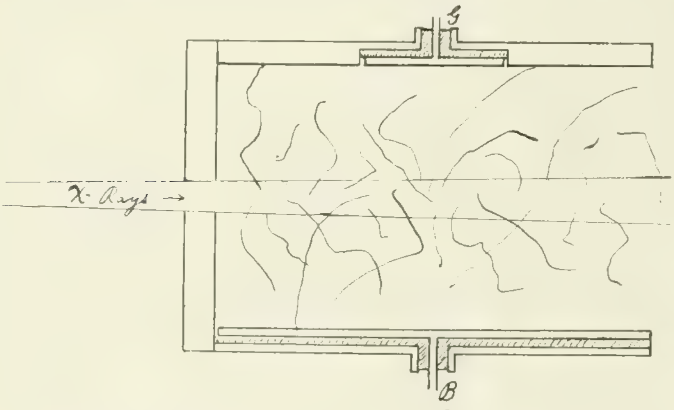


Fig. 3.

The x-ray beam enters the chamber through a hole of known area and passes between the plates without striking them. The plates are arranged in a manner similar to those in an instrument designed by Lord Kelvin and called a guard-ring condenser. One plate, connected with the battery through B, extends almost the whole length of the chamber. The other side of the chamber is divided into three sections. The two end sections are joined to the outside metal casing of the chamber, which, in turn, is connected to earth for purposes of protection. The middle section of the side, insulated from the casing, is connected through G to the galvanometer. The middle section has a certain definite breadth and draws its ionization current from an equal length of the x-ray beam. Since the x-ray beam has a definite, known cross-section, this means that the current going to the galvanometer comes from a certain volume of air. The volume of air in my instruments amounts to 25 c.c. If I get from this ionization chamber a current through the galvanometer of 25 electrostatic units, then each of the 25 c.c. of air produces one electrostatic unit and my beam has unit intensity, according to the above definition of unit beam. This is the standard ionization chamber that we use in calibrating the smaller chambers actually employed to measure the x-radiation during treatments.

There is one important point to be borne in mind in designing a standard ionization chamber of this kind. When x-rays produce ionization in a gas, a certain amount of secondary radiation is generated in the atoms and molecules of the gas by the primary beam. This secondary radiation produces a large amount of the ionization. The secondary rays, however, travel some distance from the path of the primary beam. They are of two kinds— corpuscular-rays and x-rays. The secondary x-rays are very penetrating and travel a long distance from the beam. The corpuscular rays, however, follow very crooked paths, somewhat as indicated in Figure 3, and only a few of them penetrate to a great distance from the primary beam.

---

[1] *Phys. Rev.*, Aug. 1915, p. 166.

In 1905 I pointed out that a correction must be made for the rays that strike the walls of a vessel and for secondary rays coming from those walls, if one wishes to measure quantities of radium emanation by the ionization method.[1] The correction, as determined by my experiments, proved to be proportional to the ratio of the surface of the ionization chamber to its volume. As this ratio becomes very large for small volumes it indicates a certain disadvantage in using very small ionization chambers. Theoretically, a standard ionization chamber should be indefinitely large so as to include all the ionization produced by all the secondary rays. Practically, however, the vast majority of secondary rays travel along such crooked paths that they do not get very far from the primary beam. It is not, therefore, necessary for therapeutic purposes, at least, to use very large standard ionization chambers. Those that I was using nine years ago had volumes varying from 500 to 2,000 c.c., and this appeared to be sufficient for the *x*-rays that were being produced at that time in practice.[2]

In order to test the suitability of a standard ionization chamber it is necessary, firstly, to make sure that the ionization current is saturated, and secondly, that it includes practically all of the secondary radiation coming from the molecules of gas struck by the primary beam.

The curves in Figure 4 represent the ionization currents passing through two of our standard ionization chambers of different sizes when different voltages were applied to them. The curves indicate that the current in the smaller one became saturated at about 300 volts and that the current in the larger one became saturated at about 500 volts. When using either of these chambers I employ about 800 volts, so as to be sure of their saturation.

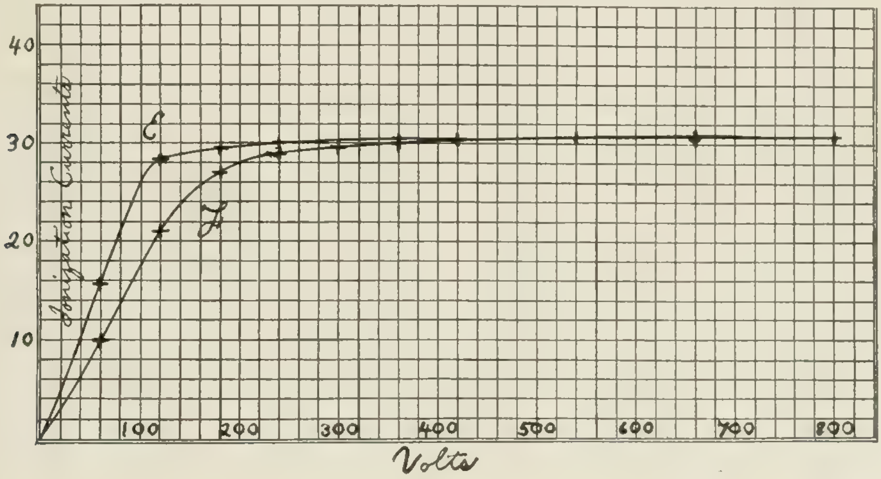


FIG. 4.

In the experiments represented by the curves in Figure 4 the voltage applied to the *x*-ray tube amounted to about 100,000 volts, and I was unable to detect any difference between the ionization current in the larger chamber and that in the smaller chamber. Either chamber, therefore, appeared to include practically all of the *x*-ray effect due to the secondary rays coming from the air in the chamber.

On using 200,000 volts, however, *x*-rays of much shorter wave-length were produced and the secondary radiation became more penetrating. In this case I found a difference of about 5 per cent between the currents through the two chambers. The larger chamber produced the larger current. On increasing the distance between the plates of the larger chamber, however, no perceptible increase in the ionization current occurred. It appears, therefore, to be large enough to use as a standard, even with rays produced by 200,000 volts. A distance of 10 cm. between the plates of an ionization chamber seems to be sufficient, if 200,000 volts are applied to the tube.

---

[1] *Compt. rend. Acad. d. sc.*, and *J. de Physique*, 1905.

[2] Friedrich employs standard ionization chambers somewhat similar to those described here.

It is, perhaps superfluous to call attention to the fact that in estimating dosage (erythema dose, for instance) it is necessary to measure the effective wave-length of the beam as well as its intensity, for the amount of *x*-ray energy absorbed by the tissues depends upon the wave-length.

These wave-length measurements may be made with either a standard ionization chamber or with one of the smaller metal chambers. It appears, however, necessary to standardize the smaller chamber for wave-length measurements by comparison with the standard ionization chamber.

One important feature of the method I am describing lies in the fact that the reading of the galvanometer gives the intensity of the *x*-ray beam and not the total dose received by the patient. In order to get the total dose we have to multiply the intensity by the time of exposure.

The large, standard ionization chambers are not suitable for measurements of the intensity during a treatment. We invariably use one of the smaller ionization chambers to measure the intensity of the beam received by the patient several times during the treatment. We measure the intensity of the rays at the surface where they enter the patient's body, and also where they emerge. This gives us an estimate of the secondary radiation coming from the patient's body. The estimate, however, is too low. Estimates may be made by means of water phantoms, placing the small ionization chamber in the water itself. This estimate is always too high. The real dose received by the patient's skin lies between the two. We have obtained quite variable estimates of the secondary radiation from different patients made by measurements taken during the treatments themselves. The secondary radiation appears to depend not only upon the size of the portal of entry but also upon the size of the patient and upon the shape, content, etc., of the portion of the body radiated. In estimating erythema doses all of these factors must be taken into consideration. The safest method appears to be to make the measurements while the patient is actually being treated.

In many of the ionization methods of measuring dosage one determines the ionization current by timing with a stop-watch the passage of the leaf of an electroscope across a scale. In methods of this kind some difficulty often arises in determining whether the current is saturated or not. Very particular attention should be paid to this point.

I might mention, also, another very common source of error in electroscope measurements. In such measurements one should always determine the "leak" in the instrument. This should be done with the *x*-ray tube running: for the *x*-rays may produce ionization currents in the electroscope (if it is not completely protected), or in parts of the apparatus other than the ionization chamber itself. Corrections must be made for the "leak," when it exists.

If one makes percentage depth dose measurements in a water phantom, one should determine the "leak" with the ionization chamber at the surface of the water, and also, at the various depths used below it. Perhaps the best way to measure the "leak" is to place a thick sheet of lead over the opening that determines the cross-section of the *x*-ray beam (the lead being thick enough to stop practically all of the *x*-rays), and then to measure the current. The leak current must be subtracted from the ionization current (obtained after removing the lead sheet), the two currents being inversely proportional to the lengths of time during which the leaf in the electroscope moves from one point on its scale to another.

If one measures percentage depth dose, the following well-known formula may be employed to correct for the leak. With the ionization chamber at the surface of the water phantom let L_0 be the number of seconds corresponding to the "leak" (i.e., when the lead plate stops the *x*-rays) and let T_0 be the number of seconds corresponding to the ionization current (after the lead plate has been removed). Further let L_1 and T_1 be the corresponding numbers of seconds, when the ionization chamber lies at any distance (say 10 cm.) below the surface. The formula for the percentage depth dose may then be written:

$$\text{P.D.D.} = \frac{\frac{1}{T_1} - \frac{1}{L_1}}{\frac{1}{T_0} - \frac{1}{L_0}}$$

If no correction be made for leak currents, and the depth dose is determined simply by dividing one length of time by another, a large error may be introduced. In one experiment that came under my observation the uncorrected depth dose amounted to considerably over 40 per cent with the tube running at approximately 200,000 volts. When the correction was made, however, the measured depth dose fell to about 34 per cent.

A great many important investigations have been carried on in connection with the question as to whether the biological effects of *x*-rays are proportional to ionization currents, when rays of different wave-lengths are used. One speaks of the biological dose. In particular cases biological doses are definite quantities. Before we can speak of a biological dose in general, however, it will be necessary to show by experiments that a large number of different biological effects are proportional to each other, when *x*-rays of different wave-lengths produce the effects.

ISODOSE CHARTS

BY OTTO GLASSER, PH.D.

HOWARD A. KELLY HOSPITAL

BALTIMORE, MARYLAND

CHARTS and tables for the distribution of intensity at various depths in the human body have been worked out for the deep therapy treatment with roentgen rays for certain types of malignant and benign tumors of frequent occurrence. Friedrich[1] of Freiburg was one of the first to determine accurately the distribution of depth intensities; the most comprehensive work in this line was done by Dessauer and Vierheller[2] with their well-known intensity charts. Duane,[3] Bachem[4] and others have made valuable contributions to this work.

Many roentgenologists, working with the charts of Dessauer, have experienced certain difficulties in their use, especially when working with American transformers. These difficulties seem mainly to be present in measuring and comparing the coefficient of weakening μ_{water} with which the quality of the used *x*-ray bundle in the Dessauer charts is characterized.

For the most common technique of deep therapy treatment, the distribution conditions were, therefore, remeasured for American transformers (3 different types used) with both an accurate small horn ionization chamber and a photometric method in a large water phantom. The conditions were as follows: 200 kv. (peak), 0.75 mm. Cu + 1 mm. Al. filter, ports of entry 20 × 20 cm. (Fig. 1) and 10 × 10 cm. (Fig. 2), 50 cm. focus skin distance. The effective wave-length according to Duane under these conditions was $\lambda_{\text{eff.}} = 0{,}15$ Au, the coefficient of weakening according to Dessauer was $\mu_{\text{water}} = 0{,}180$; both were measured with the Dessauer-Bachem electroscope. The peak voltage at the tube was exactly recorded by means of a spectrogram, taken with the Seemann spectrograph. The results of the measurements are shown in Figure 1 and Figure 2.

In these diagrams, points of equal intensities are connected with each other. All intensities in the depth are expressed in percentages of the total surface intensity 100. The curves are called "isodoses," a name I gave first to these curves in connection with radium five years ago.[5] (The name is justifiable when a practical homogeneous *x*-ray bundle and a definite time of radiation are adopted.)

These isodose charts express all the known (Friedrich, Dessauer etc.,) features of intensity distribution in the depth: main intensity (usually) in the central

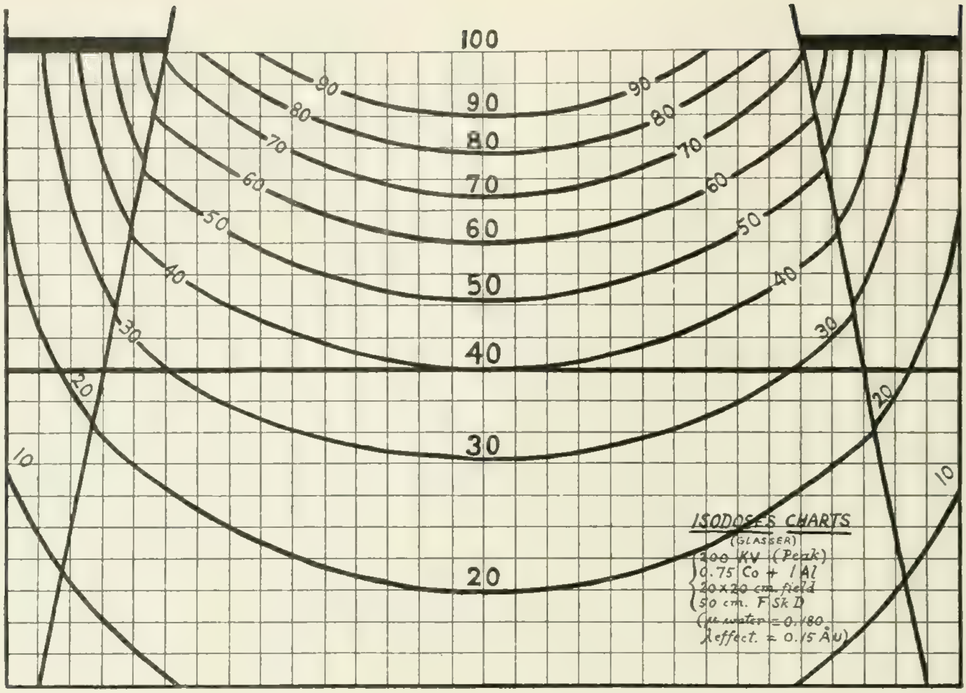

100
90
80
70
60
50
40
30
20
10
ISODOSES CHARTS
(GLASSER)
200 KV (Peak)
0.75 Co + 1 Al
20 x 20 cm. field
50 cm. F Sk D
(μ water = 0.180
λ effect. = 0.15 Åu)

FIG. 1.

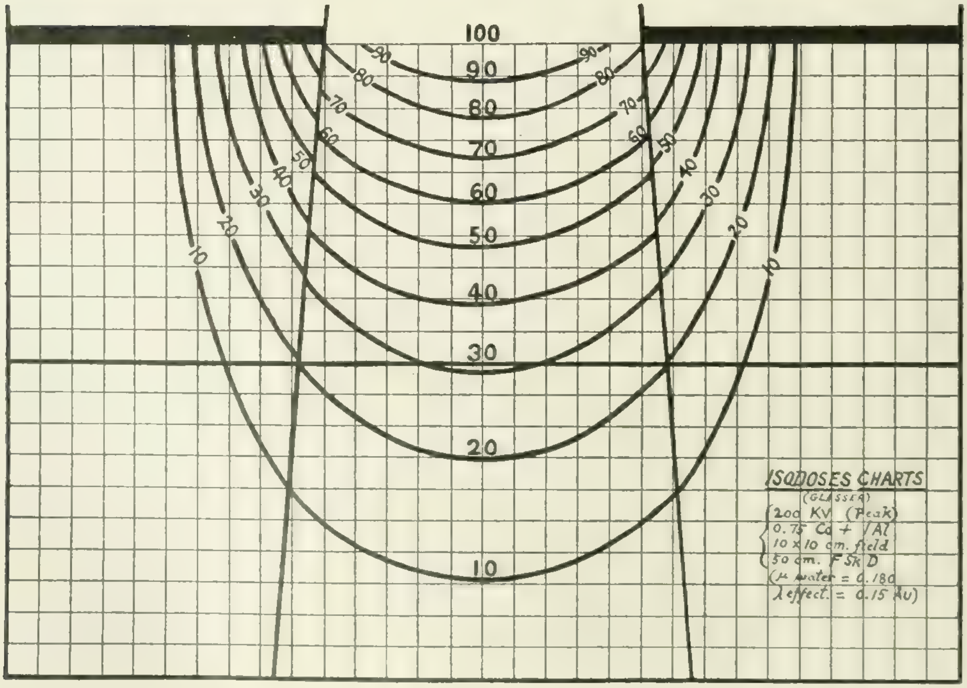

100
90
80
70
60
50
40
30
20
10
ISODOSES CHARTS
(GLASSER)
200 KV (Peak)
0.75 Co + 1 Al
10 x 10 cm. field
50 cm. F Sk D
(μ water = 0.180
λ effect. = 0.15 Åu)

FIG. 2.

beam, large differences in intensities of the central and edge beams at the same depth, high intensities at the side of the direct bundle below the lead screen, etc.

These isodose charts are intended to supplement the charts and tables now in use.

BIBLIOGRAPHY

1. Kroenig, B., and Friedrich, W. Berlin, 1918.
2. Dessauer, F., and Vierheller, F. *Strahlentherapie*, 1921, xii.
3. Duane, W. Am. J. Roentgenol., 1922, ix, 12.
4. Bachem, A. *J. Radiol.*, 1922, iii, 11.
5. Glasser, O. Diss. Freiburg, 1919.

THE IMMEDIATE EFFECT OF RADIUM AND X-RAYS ON ENZYME ACTION

BY S. CLEMENT ROTH, AND JOHN J. MORTON, M.D.

Section of Surgery, Yale University School of Medicine

NEW HAVEN, CONNECTICUT

THE histological changes which follow radiation of tissues are definite and well known, but the fundamental nature of the processes involved is still to be explained.

Many theories have been advocated[1] and rejected for lack of experimental evidence. The enzyme theory, however, is one of the most recent to be offered, and sufficient data has not been accumulated as yet to test its validity.

Packard,[2] who is the sponsor for the theory, believes that the action consists in the "activating of autolytic enzymes which bring about a degeneration of the complex proteids, etc." The work of Richards[3] is quoted as showing experimental proof in favor of the theory. He used commercial pepsin and the Mett method. After exposure of the pepsin solution to *x*-rays for a short (4 min.), moderate (10 min.), and long time (30 min.), he interpreted his results as acceleration, no effect, and inhibition of the peptic activity for the above factors. He obtained similar results with taka-diastase and starch, using the Benedict method. Willcock[4] claimed to have shown that pepsin, trypsin, and ptyalin were injured by the radium radiations. Brown[5] also thought he showed marked inhibition of the activity of pepsin, and pancreatic diastase after exposure to Radium D, E, and F, but the autolytic ferment of the dog's liver was not affected. Neuberg,[6] on the other hand, found the autolytic ferments to be accelerated; and Bergell and Bickel[7] claimed that the activity of the pepsin was enhanced. Richter and Gerhartz[8] interpreted their results with pepsin exposed to *x*-ray, using nitrogen determinations as the index, as negative; and still more recently, Lawrence,[9] on exposure of physiological diastase to unfiltered radiation from a Coolidge tube (9 in. from the anticathode, 5½ in. spark-gap at 2 ma. in secondary) reported negative findings for the effect on this enzyme.

In view of the conflicting evidence presented above, an attempt was made during the past year to study the effect of radiation on solutions of pepsin.

A review of the literature shows that peptic power is determined by measuring the transformations of various complex substrates by a large number of methods.[10] The dissolving power, the various modifications of the peptonization of the substrate, the use of new substrates, the reversal of procedures, and the application of the increasing number of biochemical methods to the analysis of the products of hydrolytic cleavage—all of these form the basis for methods. Since no method is universally accepted, the following methods were selected for trial: edestin, pea globulin,* and Mett.

Only the immediate effects were observed. The study of the late effects, though desirable, is complicated by the possibility of infection of the solutions. Large amounts of antiseptics, which must be used if the solutions are to be kept sterile for a long time, inhibit and destroy the enzyme. Sterile glassware was used throughout the experiments.

From scale pepsin (Sharp and Dohme), 1 to 3,000, 1 per cent solutions containing 0.22 per cent HCl were prepared.

---

* Professor Lafayette B. Mendell kindly supplied us with the original pea globulin prepared in his laboratory by Rose.

With edestin[11] and pea globulin[12] as substrates, pepsin solutions were exposed to the gamma rays and to *x*-rays.

Radium, amount, 50 mgm.; filtration, 0.5 mm. silver, 2.0 mm. lead, 1 mm. glass. Distance, none. Time in hours: ¼, ½, ¾, 1½, 4 and 10⅚ respectively.

X-ray: Coolidge tube, 6 in. spark (measured between points); 5 ma.; filters, none; 8 in. distance from anticathode to center of solution. Time in minutes: 1/20, 3½, and 7, respectively.

The results showed no differences between the peptic power of the radiated and the control solutions.

With the method of Mett,[13] the solutions were exposed in two series to the gamma rays of radium:

Series I. Radium, amount, 50 mgm.; filtration: 0.5 mm. silver, 2 mm. lead, 1 mm. glass. Distance, none. Time in hours: ½ and 16⅚.

Series II. Radium, amount, 100 mgm.; filtration, 0.5 mm. silver, 2 mm. lead, 1 mm. glass. Distance, none. Time in hours: ⅔, 4½ and 12⅓, respectively.

The results of the Mett method measured in the number of millimeters of egg albumin digested are recorded below. Each figure represents the average of at least 4 Mett tubes.

Series	Control	Short radiation	Moderate radiation	Long radiation
I	3.91	4.05		4.20
II	4.00	4.00	4.03	4.02

To obtain greater accuracy, gravimetric methods were tried. The weight of the Mett tube before and after digestion, and the difference in these weights was recorded. The error resulting from the presence of digesting fluid at the ends of the tubes was found to be minimized by draining the fluid with a piece of tightly-twisted absorbent cotton. Upon comparison, however, no greater accuracy was gained by this time-consuming procedure.

Human gastric juice, representing more closely a physiological solution, was then exposed to *x*-rays in the following dosage: Coolidge tube, 6 in. spark-gap (measured between points); 5 ma.; 8 in. distance; no filters; time in seconds and minutes: 10″, 3′30″, 7′12″, respectively. This dosage corresponds to ⅛, 3 and 6 MacKee units. The possibility of infection, under the conditions of obtaining gastric juice, could not be excluded. The digestive power of a solution of 15 c.c. of filtered gastric juice diluted to 100 c.c. (0.22 per cent HCl) is shown below. The figures represent the number of millimeters of egg albumin digested, the average of at least 4 Mett tubes.

Control solutions..........	1.75
10″ radiation.........	1.73
3′30″ radiation.........	1.78
7′12″ radiation.........	1.78

These readings show such slight variations from the control that they are considered to fall within the range of experimental error of the method employed. Close scrutiny of the positive results reported in the literature shows that the effects interpreted may be explained in a similar manner.

CONCLUSION

From a consideration of the results which follow the radiation of pepsin solutions by *x*-rays and the gamma rays of radium, there does not appear to be any definite effect on the enzyme activity which was determined by the edestin, globulin and Mett methods. Such slight variations as were noted fall within the limits of experimental error.

BIBLIOGRAPHY

1. MacKee, G. M. *X*-rays and Radium in the Treatment of Diseases of the Skin. New York, 1921, pp. 205–206.
   Simpson, F. E. Radium Therapy. St. Louis, 1922. pp. 86–87, 97–98.
2. Packard, C. The effects of radium emanation on the rate of cell division. *J. Exper. Zool.*, 1916, xxi, 199.
3. Richards, A. Effects of *x*-rays on the action of certain enzymes. *Am. J. Physiol.*, 1914, xxxv, 224.
4. Willcock, E. G. *J. Physiol.*, 1906, xxiii, 207.
5. Brown, T. R. *Arch. Int. Med.*, 1912, x, 405.
6. Neuberg, A. *Verhandl. d. deutsch. path. Gesellsch.*, 1904, vii, 157.
7. Bergell, P., and Bickel, A. *Verhandl. d. Cong. f. innere Med.*, 1905, xx, 157.
8. Richter and Gerhartz. Ueber die Einwirkung der Rontgenstrahlen auf Fermente. *Berl. klin. Wchnschr.*, 1908, xlv, 646.
9. Lawrence. The effects of *x*-rays on enzyme action. *Arch. Radiol. & Electroth.*, 1922, xxvi, 244.
10. Euler, Hans. General Chemistry of Enzymes. New York, 1912, p. 295.
    Effront, Jean. Biochemical Catalysts in Life and Industry, tr. by Prescott. New York, 1917, p. 249.
    Waldschmidt. Ueber die Verschiedenen Methoden, Pepsin u. Trypsin quantitativen zu bestimmen, nebst Beschreibung einer einfachener derartigen Methode. *Arch. f. d. ges. Physiol.*, 1912, cxliii, 189.
11. Edestin method: See Effront, reference 10, p. 253.
12. Rose. *Arch. Int. Med.*, 1910, v, 469.
    Givens. *Bull. Hyg. Lab.*, U. S. P. H. S., 1915, ci.
13. Mett. Beitrage zur Physiologie der Absonderungen. Weitere Mitteilungen zur Innervation der Bauchspeichedruse. *Arch. f. Anat.*, 1894, xviii, 58.
    Christiansen. *Biochem. Ztschr.*, 1912, xlvi, 257.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. · H. K. Pancoast, M.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

CHICAGO AGAIN

According to the old patriarchal custom, every seventh year was a jubilee year. The American Roentgen Ray Society met in Chicago seven years ago, and this year we come back there for a great rally meeting.

Last year we went to the Pacific Coast from a sense of duty and to demonstrate that the organization is 100 per cent American. This year we will rally in the great central metropolis for the banner meeting of our history.

The Society has practically doubled its membership since the 1916 Chicago meeting, even with its very conservative plan of development, and its meeting this year will attract a large attendance of clinicians and surgeons who are not primarily roentgenologists.

The meeting will again be in the Congress Hotel, which is centrally located on the lake front and admirably suited for the accommodation of all departments of the convention.

Dr. Hollis Potter, the President-Elect, is Chairman of the Program Committee and already has the program well under way. It is understood that his plan will be to have fewer papers and more detailed discussions, and that he will adhere to the constitutional provision that all papers must be in his hands sixty days before the meeting.

The date of the meeting will be Sept. 18th to 21st inclusive.

CORRESPONDENCE

To The Editor:

Having secured the endorsement of the Council of the American Roentgen Ray Society, I would beg leave to submit through the Journal the following plan for collective investigation by the members of the American Roentgen Ray Society and by other roentgenologists who may be interested in this project.

It seems highly desirable that there be collected for the purposes of study and investigation a large number of films of carefully studied cases. In the inception of this plan there must necessarily be taken up at first only a limited number of subjects, which number could be increased as the details of the plan are worked out.

It is suggested that roentgenologists send in to the below-mentioned address duplicate films of carefully studied cases; these films to be the property of the American Roentgen Ray Society and to be collected for the purpose of cooperative study. It is very desirable that these films should possess a high standard of technical excellence. They should be accompanied by as full clinical, operative, and pathologic data as can be secured. Each film should be carefully labeled so that it can be identified with the clinical history accompanying it.

The subject which has been chosen for the beginning of this collective investigation is "Bone Tumors." It is suggested that at first the films illustrate bone tumors of the long bones and extremities; also that, as far as possible, cases be selected which admit of a complete study. It is desired that these films should be of sufficient size to include the entire pathologic area and enough of the adjacent healthy area so that in their inspection they can be regarded as inclusive. The films should display the pathology from enough angles to make the study as precise as possible. It is planned that this collection, when classified, shall be demonstrated at the scientific exhibit of the American Roentgen Ray Society at future meetings. A plan will be devised by which lantern slides of typical conclusive cases can be available for the members of the Society.

The second subject which has been selected is "Legg's Disease" (Perthes' Disease). Films illustrating this condition should, if possible, be stereoscopic and must be accompanied by as complete a clinical record as possible. Cases should be selected preferably where the contributor considers that he will have the opportunity for observation of the case over a considerable length of time.

The third subject which has been selected is "Fractures of the Skull in Children." It is desired to secure consecutive films covering the roentgen history of fractured skulls in children. Here also it is desirable that cases be selected which will probably be under observation for some considerable length of time.

The fourth subject selected is "Joint Syphilis." Here it is highly desirable that the clinical and therapeutic data be as accurate and conclusive as possible.

As material is sent in it will be acknowledged in subsequent numbers of the Journal so that the members may be kept informed as to the growth of the collection. Correspondence and suggestions as to the method of handling these studies and the choice of future subjects for study will be very gratefully received.

Directions. Films should be packed in a flat package (*not rolled*) and should be directed to the Department of Roentgenology, University Hospital, Ann Arbor, Michigan, attention of Dr. Hickey. It is earnestly hoped that the roentgenologists of North America will respond to this opportunity of making a collection which will be of the very greatest scientific value.

P. M. Hickey.

March 20, 1893.

To The Editor:

It has frequently been noticed that certain dental films after development show a fogging at one end that has the appearance of a small tuft of fine hair, and it was supposed to be due to some light leakage in the film package. However, it was observed in separating the two films preparatory to development that occasionally a static spark was formed, and that when this occurred the films showed the hair-like appearance at one end. This also can be produced experimentally with unexposed films, by pulling them apart repeatedly in the dark room.

The knowledge of this observation has value in careful dark-room technique, as this sparking may easily be avoided by care in separating the films.

Very truly yours,
V. M. Moore.

Jan. 18, 1923.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page xiii of this number of the Journal. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

DALAND, ERNEST M. Radium treatment of keloids. *Surg., Gynec. & Obst.*, Jan., 1923, xxxvi, No. 1, p. 63.

This paper covers a large series of cases treated in the Collis P. Huntington Memorial Hospital, Boston. A small bibliography accompanies the article. As the result of his observations, the author concludes that every keloid can be destroyed by radium if a sufficient dose is used. Silver filtration (1 mm.) should be used in keloids of recent origin, in children, in people of dark complexion and in exposed areas, such as the face. The dosage should be from 30 to 60 mc. hours, according to the age of the patient. Practically unfiltered tubes should be used on all other keloids. The dosage should be from 15 to 30 mc. hours per tube. It should be explained to patients that ulceration will result from this type of treatment. There is no evidence to show that the destructive doses damage the tissues so that the lesions recur. There no lessening of the tendency of an individual to develop keloids.

MOORE, BEVERIDGE H. Subastragaloid dislocation of the foot. *Surg., Gynec. & Obst.*, Dec., 1922, xxxv, No. 6, p. 788.

Subastragaloid dislocation of the foot is a rare injury, alternative with abduction and adduction fractures in the region of the ankle. The physical signs of this form of dislocation are eversion and abduction of the foot, with prominence of the head of the astragalus in the inner side of the foot. In old cases there is lowering of the malleoli and thickening of the foot below the malleoli. Treatment in recent cases is reduction, either open or closed, as may be indicated. Total astragalectomy gives good results in old cases. Excellent roentgenograms and photographs illustrate 3 cases reported in this article.

COHN, ISODORE. Forward dislocation of both bones of the forearm at the elbow. *Surg., Gynec. & Obst.*, Dec., 1922, xxxv, No. 6, p. 766.

Anterior dislocations of both bones of the forearm are rare. Only 23 cases, including the case reported by the author, have been found in a search of the literature. In all cases which have been verified by operation or autopsy, there has been an extensive laceration of the ligaments about the joint and a stripping up of the muscles in the immediate vicinity from the respective bones.

Anterior dislocations of the elbow may be either uncomplicated, or associated with a fracture of the olecranon or coronoid process. A review of the literature suggests that some of the cases have been reduced with very little difficulty.

An excellent bibliography accompanies the article, which deals *in extenso* with the diagnosis and treatment of this condition. The treatment should always be surgical.

MOFFAT, BARCLAY W. Isolated disease of the scaphoid. *J. Am. M. Assn.*, 1923, lxxx, 87.

The author has found 42 cases of isolated disease of the scaphoid since Köhler described the first case in 1908. By roentgen ray the scaphoid is seen as a disc, from one-third to one-fourth normal in size, biconcave, or of irregular density, or opaque, the picture, of course, varying with the stage of the disease. Four new cases are added to the literature.

WHEELON, HOMER. Duodenal motility. *J. Am. M. Assn.*, Mar. 3, 1923, lxxx, No. 9, p. 615.

In view of the demonstration by recent experimenters that duodenal contents are normally regurgitated into the stomach toward the close of gastric digestion, and in view of the frequency with which reverse movements of barium are seen during radiographic examination of the gastrointestinal tract, the author undertook a number of *x*-ray observations following the direct injection of barium into the human duodenum. Barium in quantities of from 20 to 60 c.c. was injected directly into the duodenum without causing distress, the stomach and duodenum having previously been emptied of their contents. The first observed movement of the barium following injection into the duodenum is a more or less complete division of the mass at the point of greatest distention. Following the primary partial division, barium is usually passed along both directions of the duodenum, the central portion being delivered to the upper duodenum or cap, the distal portion to the jejunum. Reverse movements of barium sooner or later result in the complete filling of the cap, at which point barium may rest for a long period of time. Following distention of the cap by reverse movements, barium is passed forward by progressive movements which, at times, carry material through the point of original duodenal distention to lower segments. Barium may be delivered from the point of distention to the stomach as the result of reverse movements. In the majority of instances, barium is passed into the stomach only after several injections of the duodenum. Rhythmic segmental and pendular movements of barium occur in the duodenum. Barium tends to rest at the point of injection—inferior flexure. This region is the usual point of injection. In one instance of jejunum injection, marked reverse movements resulted in the lodgment of barium in the cap, stomach and inferior flexure.

Hollander, Edward. Fallibility of roentgenologic evidence of healed gastric ulcer. *J. Am. M. Assn.*, Jan. 6, 1923, lxxx, No. 1, p. 29.

Roentgenologic examination affords the best method of obtaining definite objective record of morphologic changes in the surface of an ulcer. It seems reasonable to interpret the diminution in size or the total disappearance of a niche as evidence of healing or cure, especially when these changes are accompanied by clinical evidence of improvement, and by other roentgenologic findings, such as the disappearance of an incisure, and improved motility. However, the author presents a case which shows that this interpretation is open to error. There are causes for the disappearance of the niche other than the obliteration of an ulcer crater by granulation or cicatricial tissue. Food may enter the crater. In the case presented mucoid material filled the crater. It has been suggested that pressure by edema or enlargement of an organ, such as the liver or pancreas, adjacent to the ulcer, may obliterate the crater. It must further be borne in mind that, even if an ulcer crater is filled with granulation tissue, the ulcer cannot be considered healed unless its surface is completely covered with epithelial tissue. This condition the roentgen ray cannot demonstrate. In the case cited by the author, the ulcer was diagnosed roentgenologically on April 30th; the medical cure announced as proved by the same method on July 2nd, but on August 3rd, at operation, a callous ulcer was found present on the lesser curvature at the point corresponding to the niche in the roentgenogram of April 30th.

Schroeder, J. Henry. Sarcoma (?) of thigh, with secondary sarcoma (?) of inguinal region, liver and lungs: Recovery after deep roentgen irradiation. *J. Am. M. Assn.*, Jan. 6, 1923, lxxx, No. 1, p. 23.

The author cites a case of a man, aged fifty, injured by crushing of right thigh. Roentgenograms do not reveal any injury to the bone. After six months a clinical diagnosis of sarcoma of the thigh was made, and amputation advised. Routine examination with the *x*-rays revealed extensive and typical secondary sarcoma of both lungs. From Jan. 21st to Feb. 1st, the thigh, inguinal region and both lungs were irradiated, each region receiving in its depth the full dose in one sitting (for the lungs, 70 per cent of erythema dose at 200 kv., and for the other areas, 80 per cent of the surface erythema dose at 220 kv.). The sarcoma dose was again administered to the thigh and the lungs between March 22nd and March 27th. At the beginning of the third period of irradiation, June 29th, the liver was found to be markedly enlarged and very tender, and at this time the liver and the thigh were each given the sarcoma dose. During the fourth period of treatment, August 21st, the thigh received its last irradiation. This excessive irradiation was well tolerated. There were no alarming blood changes after the various doses. At the present time the patient is free from any evidence of the disease, his general condition being excellent. Only the muscles of the leg have not gained their former strength. The lungs became entirely clear after the second dose.

The author feels that the case demonstrates that widely disseminated sarcoma is in itself not a bar to successful treatment with deep roentgen irradiations. Nine months ago this patient was lying in a hospital, hopeless and helpless; today he is looking forward to a renewed useful existence.

Stokes, J. H., and Gardner, Boyd S. The demonstration of unerupted Hutchinson's teeth by the roentgen ray. *J. Am. M. Assn.*, Jan. 6, 1923, lxxx, No. 1, p. 28.

In any large syphilologic practice, cases are occasionally encountered in which the fact that the child's teeth are still of the first dentition makes it impossible, in the absence of other conclusive evidence, to clinch the diagnosis of heredosyphilis by the identification of true Hutchinson's teeth. In such cases, it seems possible that intra-alveolar identification of Hutchinson's teeth by the reontgenogram may be of diagnostic service. It is only necessary to study the unerupted upper incisors to get the full benefit of the dental examination in such patients.

Thedering. *X*-Ray stimulation doses and diseases of the hair. *München. med. Wchnschr.*, Oct. 6, 1922, lxix, No. 40, p. 1430.

The effect of the epilation dose on the healthy hair demonstrates absolutely the meaning and extent of the Arndt-Schulz biologic basic law: "Weak stimuli increase, moderate stimuli inhibit cellular activity; strong stimuli destroy the cell." In raying the beard with the epilation "11 X" doses through ½ mm. aluminum filter we may observe increasing growth of the beard due to the gradually increasing wave of reaction. Patients voluntarily state that they need a shave more frequently. After a fortnight the beard stops growing and with the third week epilation sets in.

The theoretic object of applying roentgen radiation to the hair is threefold and corresponds to the three different biologic stimulation doses. It aims to stimulate slow-growing hair; temporarily to remove diseased hair; permanently to remove troublesome hairy growth (beard in women).

Temporary epilation is mostly employed in parasitic diseases of the hair follicles—sycosis and trichophytosis—and has been practiced for over a decade in *x*-ray therapy. Permanent epilation in inconvenient bearded growth has likewise become common practice and proved a safe, harmless, successful method if applied with a sufficiently thick (4 mm.) aluminum filter by an experienced specialist.

The *stimulation dose* is little employed, if one is to judge by the published reports. In 1900, Kienboeck, and about that date Holzknecht also, published reports of successful roentgen radiation in alopecia areata. However, their suggestions were forgotten, probably because they applied the epilation dose which first provokes depilation and stimulates the paralyzed papilla only after the reactionary wave has subsided. Total depilation for three months may actually be considered too radical a process on account of a few individual foci in alopecia areata, all the more since Nagelschmidt and Bering successfully apply the *quartz light* and have found it a milder therapeutic agent for insuring a new growth of hair. We may thus well understand why such eminent radiologists as Wetterer and Krohmayer refuse to treat alopecia areata with the *x*-rays.

So long as the technique of dosage was not perfected, it was reasonable to look askance on a method in which the wrong dose might induce temporary or even permanent depilation instead of stimulating the growth of hair. The modern technically educated roentgenotherapist need not fear this criticism.

The author believes himself the first to suggest substituting *x*-ray stimulation dose, based on the above biologic principle, for quartz light treatment in alopecia totalis, in his book on "Quartz Light," 1916, and his article, "Radiotherapy in Alopecia Totalis," 1916. The stimulation dose consists in raying the scalp with about ½ of the epilation dose through ½ to 2 mm. aluminum filter through four fields once in two weeks until the hair grows again. In the course of years the author has increasingly substituted for quartz light treatment this *x*-ray stimulation radiation in alopecia areata, seborrhea, etc. It has the advantage of more pronounced, permanent and deep effect; of absolutely certain detection of hidden foci in systematically raying the thick hair of women. Quartz light therapy of these cases requires careful and time-consuming parting of the hair and even then beginning foci may be easily overlooked.

The excellent results obtained in various diseases of the hair are discussed by the author in his recent publication, "Diseases of the Hair and Baldness: Prevention and Treatment with Light and Roentgen Rays," Oldenburg, 1922. It is intended to prove that roentgen stimulation dose, as the most modern idea of scientific therapy, may be successfully employed in those diseases.

Purcell, C. E. An Interesting *X*-Ray Study of a Foreign Body: Honey Locust Seed in the Right Bronchus. *Kentucky M. J.*, Aug., 1922, xx, 529.

The author reports a case of a child of twenty-four months who swallowed one of two honey locust seeds. The first *x*-ray plate gave an absolutely negative finding. The companion seed, which the parents brought along, was then placed on an *x*-ray plate and gave a good shadow of the seed. This companion seed was then placed on a plate underneath the child and its position marked by a pair of hemostats. This roentgenogram showed the companion seed very plainly. There were no physical signs of obstruction in the lungs—no difficulty in breathing and no other symptoms to suggest the presence of a foreign body in the lung. Laryngoscopy revealed a severe laryngitis. By noon of the following day it was observed that the child had some difficulty in breathing when it played or walked around the square. It became irritable and developed a slight rise of temperature. Under general anesthesia a bronchoscope was passed and the seed easily removed from the right bronchus.

The author concludes, therefore, that a foreign body can remain in the air passages without any symptoms, especially early symptoms, during the first twelve hours. The published roentgenograms do not reveal any signs in the chest which would indicate pulmonary changes due to the presence of a foreign body.

Daels, Frans. Histological Pictures Representing the Cure of Uterine Basocellular Epithelioma. *Proc. Roy. Soc. Med.*, Apr., 1922, xv, 19.

According to the author, in proportion to the intensity of the action of the irradiation upon the cancer cells of the uterine basocellular epithelioma, the following phenomena are observed. They are changes not met with in cases of spontaneous degeneration, namely:

1. Massive and rapid caryorrhexis of the cancer cells without any intervention on the

part of the blood-cells or any profound degeneration of the normal tissues.

2. Progressive necrosis occasioned by pycnosis or achromatosis, with eosinophilia or vacuolization of the protoplasm and phagocytosis by polynuclear blood cells; this destroys quite a large number of alveoli; this well-marked phenomenon is here specially characteristic of the action of the irradiation.

3. The transformation of the cancer cells into giant cells and giant nuclei—an alteration that may lead to necrosis with invasion by polynuclear leukocytes, or to a gradual atrophy with fatty degeneration of the protoplasm and disappearance of those elements without any participation of leukocytes in the process.

The action exercised by the irradiation—radium irradiation more especially, but however not exclusively, since one often added irradiation by *x*-rays after radium treatment—first affects the nucleus and sets up an actual rupture of the nucleus comparable to the action of the irradiation upon the lymphocytes: or else a destruction of the nucleus, sometimes combined with eosinophilia or the megakaryocytic-shaped degeneration which seems to result from nuclear fusions due to loss of karyokinetic power.

The author's observations lead him to admit that the polynuclear leukocytes only occur in association with spontaneous degenerations or with radio-therapeutic transformation of the basocellular epithelioma, as a consequence of incidental infections or the necrosis of cancer cells, and that they do not take an active part in the elective regression proper. And so it must also be admitted that the connective tissue has no active participation in the regression proper, as one meets with the most excellent definition of regression in the midst of the empty space remaining after the disappearance of the cancer cells. On the other hand, it seems that a special significance of effective reaction against the cancer proliferation or its agent must be ascribed to infiltration of leukocytes.

4. The appearance of giant cells without the characteristics of malignant tissue, sometimes with a distinct follicle shape, the appearance of true histological follicles as a consequence of radium irradiation of cancer alveoli, lead us to the adoption of the hypothesis of the liberation of a germ or agent to which the body is supposed to react by lymphocytic infiltration and formation of giant cells. The observation should be connected with the two different sarcomatous and follicular reactions of the body upon the bacillus of Koch. The histological appearances found upon the healing of the follicle that arises after experimental injection of killed Koch bacilli should be remembered in this connection, namely, formation of giant cells, fusions of the nuclei, formation of megakaryocytic elements, progressive liberation and atrophy of these megakaryocytes. These phenomena have the greatest resemblance to those observed in the case of cancer regression.

Smithies, Frank. Necessity for Caution in the Employment of High Voltage Roentgen Rays as a Therapeutic Agent Against Malignant Disease: Acute Adrenal Insufficiency and Death as Sequelae. *Surg., Gynec. & Obst.*, Jan., 1923, xxxvi, No. 1, p. 61.

The author of this paper has evidently failed to note the numerous warnings with which the literature of deep roentgenotherapy is filled, and states that "literature has carried very few, if any, criticisms upon or warnings against the new roentgen therapy." Nevertheless, the details of a case of fatal acute adrenal insufficiency following deep therapy is very instructive. The patient, aged fifty-eight, was treated by deep therapy on an erroneous diagnosis of sarcoma of the spine. The author's report of the amount of treatment given is too vague to warrant repetition here. Within a month following the roentgen therapy the patient began to experience unusual fatigue upon slight exertion, and within two months the diagnosis of bilateral adrenal insufficiency was clear to the author. In spite of intravenous injection of adrenalin and salt solution in heroic doses, followed by partial return to consciousness, the patient died from exhaustion and cardiorenal failure. Unfortunately no post-morten study was permitted.

The author summarizes the evidence in this case as follows: "Instances of 'acute' or 'fulminant' Addison's syndrome are rare; it is most unusual to have the disease appear after the age of fifty and exitus to occur in less than a year. An instance of death from the Addisonian syndrome, within four months after 'deep' roentgen therapy of long duration and very high voltage, in a man aged fifty-eight is recorded. The roentgen seances were given as curative measures for supposed malignancy of the spine (a diagnosis subsequently shown to have been faulty). It can scarcely be presumed that this patient's fall from his horse produced simultaneous acute, double-sided adrenal injury and failure. The man was very 'fit' when he sustained what seemed to be nothing more than muscle bruises to his paraspinal group. He remained 'fit', despite his slight muscular lameness, until a few weeks after roentgen exposures, and his collapse afterward was rapid.

"The proximity of the adrenals to the areas treated by the high voltage *x*-rays for long time-intervals strongly suggests that this form of therapeusis was an agent responsible for the acute collapse of adrenal function and doubtless the destruction of chromaffin tissue. Unfortunately, autopsy was denied: the cause of the disability and death were, however, unmistakable."

Hyman, A. Diverticula of the Bladder in Children. *Surg., Gynec. & Obst.*, Jan., 1923, xxxvi, No. 1, p. 27.

Vesical diverticula are rare findings in childhood, not more than 30 being found in a review of over 600 cases.

Diagnosis of this condition in children should present no difficulties. Little value can be placed on the history. Physical examination of the abdomen is of considerable importance. A chronically distended bladder especially asymmetrical in outline, should make one suspicious of a diverticulum. The cystoscope and the cystogram are absolutely essential in making a correct diagnosis. Of the two, the cystogram will be found more valuable. Cystoscopy is at times difficult in the young, especially in the presence of a marked pyuria, when it may be impossible to cleanse the bladder sufficiently to obtain a clear picture. Even cystoscopy gives no idea of the size and shape of the pouch, although it reveals the presence of the orifice. Cystography can be performed, even in very young children, without the slightest difficulty, and requires no anesthetic. The roentgenograms should be taken in different positions, otherwise a small sac may be overlooked or the shadow of the diverticulum may be obscured by that of the bladder itself. In young children conditions are especially favorable for obtaining roentgenograms in the lateral as well as in the anterior positions. Additional information may be obtained if one makes a plain roentgenogram, after which the solution is drained off and air injected into the bladder and another plate taken. The air-filled bladder stands out in contrast to the sacs which still contain the opaque solution.

The presence of diverticula in patients so young, without evidence of any obstruction, leads one to conclude that they were congenital and that in all probability many of the diverticula in adults have also a similar origin.

Hochstetter, F. Duodenal Stenosis Following an Ancient Tuberculous Peritonitis. *Fortschr. a. d. Geb. Röntgenstrahlen*, xxix, 2.

This case is interesting because of the successful roentgenological diagnosis made of duodenal obstruction. The stomach and the duodenum were converted into one large sac without any visible separation at the level of the pylorus, both organs having the caliber of a dilated stomach. Operation revealed a very tight stenosis of the small intestine at the jejunoileal junction and the presence of multiple adhesions involving all the organs of the abdominal cavity.

Chappel, Halbert W. The Necessity for an Immediate and Thorough Roentgenological Study of All Injuries to the Spine. *Calif. State J. M.*, Dec., 1922, xx, 436.

The author cites 15 cases in which roentgenological examination was of the greatest assistance in connection with injuries to the spine, and in many of which a thorough roentgenological study immediately following the injury would have been the only means of arriving at a correct diagnosis.

Keiffer. The Mechanism of Retrogression of Human Uterine Fibroids. *J. de Radiol.*, 1922, ix, 95.

According to the author, the mechanism of the diminution in size of uterine fibroids in the human is variable, and he has only been able to establish clinically a diminution in volume and a softening of the fibrous nuclei, and, with the microscope, atrophy with progressive sclerosis. In the course of and following pregnancy, certain uterine fibroids may disappear by a complex mechanism, especially that of a light lipolysis associated with other degenerative processes. After the menopause the retrogression is observed in the form of a simple sclerosis. In hysterectomies performed after the application of radium or *x*-rays, the author has frequently found a veritable central necrosis of the fibrous nuclei associated with all the other signs of degeneration observed in the fibrous uterus after pregnancy and in the course of the physiological menopause.

Cooke, A. B. When Appendicitis Is Not Appendicitis: A Case of Diverticulitis of the Cecum. *J. Am. M. Assn.*, Feb. 25, 1922, lxxviii, 578.

The author reports a case in which an operation for what had been diagnosed as appendicitis revealed a well-marked diverticulitis of the cecum, the appendix not being involved. A total excision of the cecum was successfully performed. The specimen showed a diverticulum of the cecum which had harbored a concretion. This concretion as it increased in size caused a pressure necrosis and an extensive inflammatory deposit. This case is interesting to the roentgenologist as illustrating some of the diagnostic possibilities in the ileocecal region.

SAGET, M. The Intensiometer. *Bull. et mém. Soc. de Radiol. méd. de France.* Nov., 1922, No. 93.

The intensiometer is based upon the same principle as the ordinary iontoquantimeters, but it possesses certain advantages over those without their inconveniences. As its name indicates, it is intended to measure the intensity of ionization, and gives, therefore, the measure of intensity of a given bundle of *x*-rays. This ionization chamber consists of a series of paper discs covered with a thin layer of carbon conductor, but held apart parallel to each other at an interval of 1 cm. by peripheral isolating rings. These discs are alternately connected to the two terminals of the ionization chamber, and constitute thus a sort of condenser with parallel sheets of which the dielectric will be the contained air ionized by the *x*-ray which passes through it.

A double envelope of lead and aluminum constitutes the lateral walls and assures protection against diffusive radiation. The upper surface, through which passes the radiation to be measured, consists of a sliding drawer, permitting easy insertion of the filters to be used. The lower face of the instrument consists of a wooden plate 22 mm. thick, pierced by a groove to receive the ionization chamber of Solomon's ionometer for the purpose of comparing the measurements furnished by the two instruments.

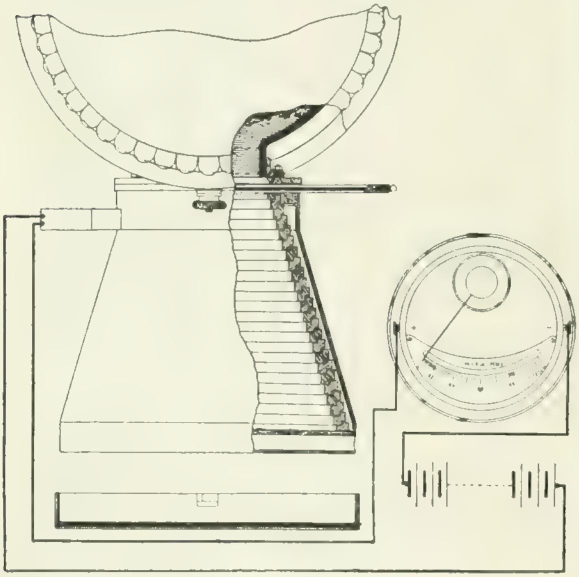


FIG. 1.

The external dimensions of the cone are as follows: Inferior diameter, 29 cm.; total height, 26 cm. It corresponds to a cone of 25 cm. in diameter for a distance of 40 cm. from the tube-target. The volume of the ionization chamber at this distance is about 11 liters. This ionization chamber is placed in the circuit of a storage battery with a direct reading needle galvanometer. This apparatus is as sensitive as can be practically constructed. It registers a deviation as small as two micro-amperes.

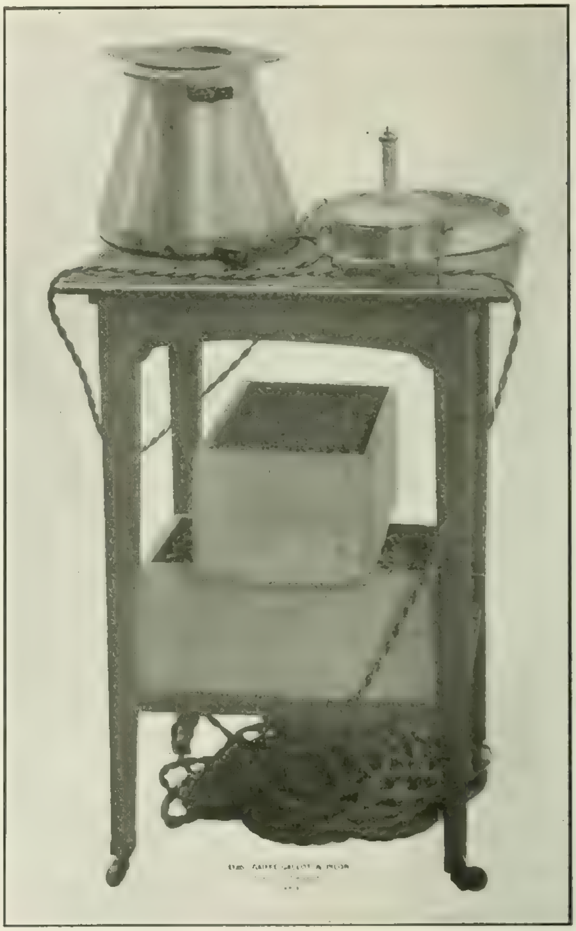


FIG. 2.

The storage battery especially designed for this work consists of a hundred Fery dry cells, small model, which should give service during several years without repairs.

The different apparatus are connected with each other by a very supple cable having two conductors perfectly isolated and not permitting any appreciable loss by ionization.

The use of this apparatus is very simple. Under the influence of radiation the different layers of air of the apparatus are ionized and permit the passage of a current, the intensity of which is instantly read on the galvanometer.

This intensity is rigorously proportional to the intensity of the radiation. The readings depend upon the absorptive power of the filters employed.

The intensiometer can be utilized each time it is necessary to determine the thickness and the nature of filters. It is indispensable in case one desires a constant control of the good functioning of his tube or generator. It gives an instant reading of the measure of the intensity of the radiation employed, just as the milliamperemeter gives the measure of current passing through the tube.

The diameter of the orifice through which the ray passes is 25 cm. One can reduce this dimension by the employment of lead diaphragms, the form and dimensions of the opening being determined according to the case.

The ionization chamber is intended to be attached to the tube holder just as the cylinder diaphragm is ordinarily attached to tube holders employed by American roentgenologists. In France this is especially interesting because the holders for maintaining the oil-immersed tubes can be touched by the patient with impunity. Doubtless before long, modifications of this apparatus will be available for use with American instruments.

Herman, N. B., and Von Glahn, William C. Carcinoma of the Supra-Ampullary Portion of the Duodenum. *Am. J. M. Sc.*, Jan., 1921, No. 1, clxi; No. 586, p. 111.

One case is reported: Male, seventy-eight years old, complaining some months, upset stomach; lost 10 lbs. in a year; no bloody stools.

Laboratory Findings. Blood. Red blood cells, 3,048,000. White blood cells, 5,750. Hemoglobin (Sahli) 45 per cent. Differential formula showed a slight polymorphonuclear leukocytosis.

Urine. Sp. gr., 1.010 to 1.015. Persistent trace of albumin. Granular casts.

Sputum. Positive for tubercle bacilli.

Stool. Bile present. No ova or parasites. Positive for occult blood. (Benzidine and guaiac tests.)

Test-meal. 100 c.c. of brownish fluid. Bile, 0. Lactic acid, 0. Test for occult blood strongly positive. (Benzidine and guaiac tests.) No Oppler-Boas bacilli. Free HCl, 17 per cent. Combined, 16. Total, 33.

Wassermann. Negative.

Roentgen-Ray Report (Dr. J. W. Pierson). Chest. Marked spotty infiltration, both uppers, more extensive on the left than on the right; tuberculous in origin.

Gastrointestinal Series. Stomach lies low in the pelvis: marked filling defect in region of antrum pylori, probably due to pressure from lumbar spine; pylorus intact; no retention; duodenal cap well filled. Due to weakness, the patient could not be fluoroscoped.

Course in Hospital. Patient became progressively weaker. He vomited small amounts of fluid material at times. His chief complaint was difficulty in swallowing, but since a stomach-tube passed easily this was thought to be due to a reflex cardiospasm rather than to an organic esophageal obstruction. On the night of February 10th he showed active delirium. On February 11th he sank into a semicomatose state and died February 12th.

Clinical Impression. Ulcerative pulmonary tuberculosis. Carcinoma of the stomach. Secondary anemia.

Autopsy, No. 1592. *Anatomic Diagnosis.* Chronic fibroid pulmonary tuberculosis with bronchiectasis; ulcerative tuberculous enterocolitis; conglomerate mass of tubercles in the wall of the aorta; generalized miliary tuberculosis; adenocarcinoma of the duodenum; thrombosis of the right common iliac and right pulmonary arteries, left common iliac vein and prostatic veins; arteriosclerosis; right inguinal hernia, undescended testicle, right; brown atrophy of the heart.

Stomach and Duodenum. The stomach is moderately distended with gas and fluid, especially the pyloric portion. The duodenum, just beyond the pylorus, is enlarged and a dense mass can be felt in it, apparently entirely filling the lumen. The serous surfaces of the stomach and duodenum are smooth and glistening.

When opened, the stomach shows no changes. A finger can be readily introduced through the pyloric orifice, but the opening is eccentrically placed and a firm mass can be palpated in the duodenum, completely encircling the finger. This mass is a large, oblong, solid, polypoid tumor, attached to the inferior wall of the bowel and arising just beyond the pylorus. It measures 6 × 5 × 3 cm. in its greatest diameters. The base is somewhat smaller than this. The surface of the tumor is smooth and rounded, with small hemorrhages here and there. The upper surface is hollowed out into a deep gutter with steep sides, which gradually taper as they extend upward, and, conforming to the curve of the bowel wall, they overlap above, forming a tunnel through which the gastric content passed. It was into this tunnel that the finger readily entered. When the bowel was opened these margins sprang apart. The tumor is grayish white in color and cuts with some resistance. The cut surface is rather homogenous in appearance and is dotted with a few yellow flecks. The growth seems to penetrate only a little way into the wall of the bowel. The duodenal mucosa is gray and translucent and is reflected for a short distance upon the base of the tumor. The folds of the mucosa are well defined and prominent. The ampulla of Vater is negative. The regional lymph-glands are not enlarged and there are no metastases visible in the liver.

Microscopic Examination. The tumor is composed of columnar epithelial cells, having a definite glandular arrangement. Often these cells are heaped up into several layers. There is an abundant and rather dense connective-tissue stroma in which are many capillaries and which is infiltrated with small round cells, plasma cells and leukocytes. The gland-like spaces enclosed by the epithelial cells are frequently filled with leukocytes. Small areas of necrosis are seen. At the base the rather orderly adenomatous arrangement is lost, and the cells are more irregular in size and shape and grow in solid cords, penetrating into the circular layer of muscle. Mitoses are fairly numerous. The mucosa can be traced upward upon the tumor for a short distance, then it ends abruptly. In appearance and arrangement the tumor cells resemble more closely those of the glands of the mucosa than those of Brunner's glands. In none of the sections of the regional lymph-glands could any metastases be found. Sections of the liver and pancreas were likewise negative for metastases.

SANTE, L. R. Pneumoperitoneum as an Aid in the Diagnosis of Subdiaphragmatic Conditions. *J. Am. M. Assn.*, Feb. 17, 1923, lxxx, No. 7, p. 464.

The author has found pneumoperitoneum of so much value in examinations of acute infectious involvement of the subphrenic space that it seems advisable to call attention to this special phase of pneumoperitoneum work. Very little air is necessary in the examination of this region, and, if inflation is carried on with the patient in a recumbent position under the fluoroscope, any involvement of this space can be at once detected, and the inflation discontinued. If the procedure is carried out in this fashion, there need be little fear of breaking any existing adhesion walling off an infectious process, no matter how delicate or recently formed. Information gained in this manner, either establishing the presence of a subdiaphragmatic abscess or excluding its possibility, is of the utmost value in the prognosis and treatment of the condition. This is especially true since the accepted method of surgical procedure for drainage of such abscesses is very extensive and necessarily involves vital structures. The author cites a number of cases where this method assisted materially in the difficult diagnosis including empyema, perinephritic abscess, cardiospasm, adhesions of the viscera to the diaphragm, and hernia of the hollow viscera through the diaphragm.

COOPER, J. R. Fibroma of Stomach. *J. Am. M. Assn.*, Feb. 24, 1923, lxxx, No. 8, p. 549.

The author reports a case of a male, aged forty-five, suffering from gastric and intestinal hemorrhages. Two years previously the patient at times became dizzy, and his stools after these spells were dark and of a tarry consistency. A year later, his dizzy spells became more pronounced and he occasionally vomited blood in considerable quantities. The preroentgen diagnosis was ulcer of the stomach or duodenum. The roentgen study before administering the opaque meal showed, extending into the gas bubble of the stomach, a tumor-like mass about as large as a medium-sized orange. It was observed to rise and fall with respiration, and no pulsation could be seen. With the stomach filled with the barium mixture the tumor could not be seen. Aneurism of the abdominal aorta was thought of; but the Wassermann reaction was negative and there were no pulsations. At operation a fibromyoma, the size of an apple, was removed from the cardiac end of the stomach. The tumor was growing from the anterior wall, about an inch and a half from the cardia. The pathological report showed fibromyoma with a large ulcer in the mucous surface.

KNAPP, HARRY B. Dislocation of the Semilunar Carpal Bone. *J. Am. M. Assn.*, Dec. 9, 1922, lxxix, 1992.

The mechanism of semilunar carpal bone dislocation is the same as that which produces the common Colles' fracture, this mechanism being the sudden, forcible hyperextension of the wrist. If the anterior radiocarpal ligament is ruptured by the hyperextension, the semilunar carpal bone is apt to be dislocated anteriorly. This ligament usually does not rupture, but the radius, instead, is fractured. Thus fracture is many hundred times more common than dislocation.

Diagnosis is easily made from a roentgenogram taken in the lateral position, which shows the moon-shaped bone more or less completely rotated forward, boldly jutting out of its place in the general alignment of the wrist structures. The length of the hand appears shortened, owing to the settling of the os magnum into the space left by the semilunar. The anteroposterior diameter of the wrist is increased and the semilunar bone may be felt as a hard, perhaps movable prominence beneath the flexure tendon in the anterior wrist region.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X JUNE, 1923 No. 6

CARCINOMA OF THE SMALL BOWEL*

BY MILTON M. PORTIS, M.D., AND SIDNEY A. PORTIS, M.D.

CHICAGO, ILLINOIS

CARCINOMA of the small bowel is a comparatively rare lesion. Ewing states that it comprises 3 per cent of intestinal carcinoma. Of the 41,858 necropsies at the Vienna General Hospital, 3,585 were cases of carcinoma. Of these, 343 were in the bowel, and only 11 of these were in the small bowel. Hinz found, among 584 cases of carcinoma of the intestinal tract, that only 18 were located in the small bowel. Johnson, in a recent paper, reported 2 cases of carcinoma in the jejunum and one in the ileum. Bevan reported 5 cases of cancer of the jejunum. Cancer of the duodenum is reported by Lichty in 6 cases, McGuire, 4 cases, Herman, 2 cases, Jefferson, Deaver and Head each, 1 case. Judd reported 24 cases, 5 of which were in the duodenum, 11 in the jejunum and 6 in the ileum, and 2 multiple cases. About 70 per cent of the cancers of the duodenum are located at the ampulla.

These tumors of the small intestine, according to Ewing, are of three distinct forms:

1. Part of a local or general intestinal polyposis. This is rather rare in the small intestine, being more frequent in the colon. This type probably explains the occurrence of multiple carcinoma with several strictures produced.

2. Multiple or single benign embryonal carcinoid tumors, which are usually found in the ileum and jejunum in the form of single or multiple firm opaque nodules as large as a pea or bean. They lie in the mucosa or submucosa. In structure they form three groups:

(*a*) Pancreatic island tissue.

(*b*) Heterotropic intestinal mucosa.

(*c*) Brunner's glands.

3. Localized adenocarcinomas arise under various conditions, from single intestinal polyps, and tend to maintain an adenocarcinomatous structure. The majority of the intestinal carcinomas are of this type. When ulceration is delayed, the tumors may reach sufficient size to obstruct the lumen. Ulceration and stricture more commonly result. Metastases are present in about one-third of the cases, and involve the mesentery, liver, lungs and peritoneum.

The clinical picture is variable, depending on the type and age of the carcinoma. In the early cases, before obstruction, there may be no subjective symptoms, and the patient may not be aware of the presence of the tumor until obstructive symptoms appear. Although hemorrhage is uncommon, yet, even in the earliest stage, erosion occurs, and occult blood is found in the stools. This is of greatest importance in an early diagnosis.

As is common in carcinoma in any part of the body, loss of weight and anemia take place. Asthenia and a vague abdominal discomfort are complained of. Later, pain is felt, and this increases as obstruction begins. It may be colicky and paroxysmal, especially when there is much tympanites. A progressively developing constipation is complained of, especially with definite stenosis at the tumor site. At times, constipation does not appear at all, but diarrhea is present. Rarely, constipation alternates with diarrhea. Very soon, stomach symptoms appear. Belching and nausea, anorexia and thirst are complained of, and later vomiting begins. The vomiting is frequently repeated as often as 6 to 8 times daily, and the vomitus is usually of a greenish color. In a well-developed case it may have a brownish color and a fecal odor. The typical picture of intestinal obstruction appears with the closure of the stricture.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922.

The triad of symptoms which are of diagnostic value is a stubborn constipation, with or without alternating diarrhea, severe attacks of colicky pain, and vomiting.

Objective symptoms are not found early, but with developing stenosis there is tympanites, visible peristalsis, and a tumor may be palpated. The tumor is usually small and firm. It is movable and changeable in location. With marked vomiting there may be pronounced dehydration and signs of severe intoxication.

Laboratory studies of the gastric contents do not show evidence of disease. The stools rarely show gross blood, but occult blood is usually found, and is the most reliable of the early findings. The *x*-ray is of great help in the diagnosis. A normal stomach and duodenal bulb help to rule them out as a cause for the occult blood. The duodenum is usually dilated and likewise, the small bowel proximal to the stenosing tumor. Gas and fluid are found in the distended bowel. The amount of dilatation found will naturally vary with the duration of the tumor, and the amount of stenosis produced by it. In the cases in the literature, an early diagnosis was not made, and only at operation for acute obstruction was the tumor found. This is too late for a cure. A routine examination of all stools for occult blood will be of decided help in discovering these lesions early enough for operative aid. In the differential diagnosis, tuberculosis must be ruled out carefully. Actinomycosis at times gives a similar picture and rarely, syphilis.

We wish to report a case referred by Dr. Plummer in 1917. A woman of fifty-two complained of nausea and vomiting and rapid loss of weight. She had considerable abdominal distress. There was marked tenderness in the upper abdomen, but no mass could be felt. The stomach test was normal and the stool showed occult blood constantly. The *x*-ray examination made by Dr. Jenkinson revealed a normal stomach and duodenal bulb, but there was a delay in the emptying time. The duodenum was dilated, and likewise, the jejunum proximal to a definite constriction in it. The right lower lobe of the lung showed several small, round, solid areas, which suggested metastases.

Because of the uncontrollable vomiting, Dr. Plummer operated and found a ring carcinoma of the jejunum near the duodenum. The mesenteric glands were definitely involved. A gastrojejunostomy was done. Unfortunately, the plates in this case have been misplaced.

A second case was referred to us by Dr. Christofferson, and it is through his kindness that we are presenting it to you. A male, thirty-four years old, complained of epigastric distress, vomiting, loss of weight, weakness, night sweats and tinnitus. For the past six weeks he had had abdominal distress with swelling on the left side. The swelling was intermittent and accompanied by cramp-like pains, and visible peristalsis. Vomiting occurred at a later stage, and he brought up food eaten twenty-four hours or more before. At times the vomitus had a fecal odor, and was green to yellow in color. The trouble came on at intervals. At first the attacks occurred once a week, but later, as often as twice a week. Between attacks he felt fairly well. An enema brought no relief. In the previous six weeks he had lost 20 lbs., and felt very weak. He had had no night sweats. Constipation began several weeks before and was now very stubborn. Bowels would not move without an enema.

Physical signs of the heart and lungs were normal. The abdomen was distended, but no peristalsis was visible. No mass could be felt. There was tenderness on the left side, just above the level of the umbilicus. The stomach test was normal, except for delay in emptying. The stool showed a marked reaction for occult blood. His Wassermann test was negative, and there was a secondary anemia. The Von Pirquet test was slightly positive. The urine showed a high indicanuria.

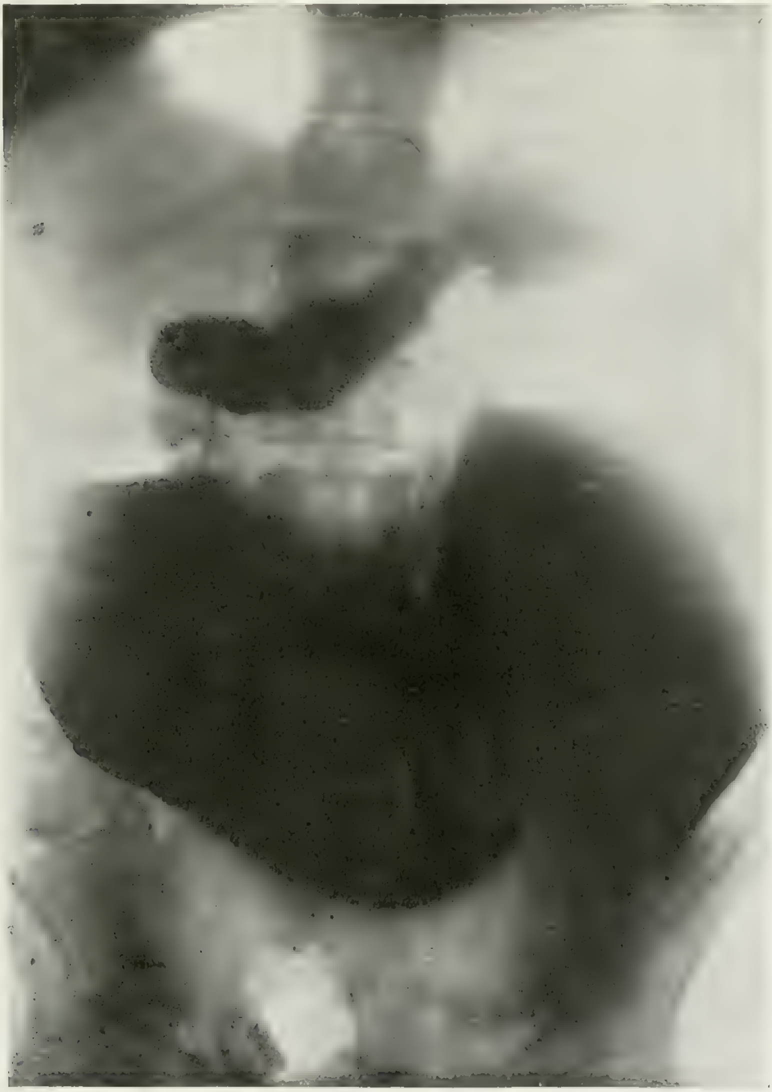


Fig. 1.

The *x*-ray showed normal chest findings. The stomach was in a transverse position, but was normal in its findings. The duodenum was dilated. The small bowel near the duodenum was filled, and remained so, giving the appearance of a stomach with air space above a fluid level. (See Fig. 1.) The bowel at the point distal to the dilatation showed a definite constriction. Reversed peristalsis was seen in the dilated portion proximal to the constriction. Operation was advised for a probable tumor of the jejunum. Dr. Christofferson found an annular growth in the jejunum near the ileum. A resection and a lateral anastomosis were carried out.

A specimen of the excised tumor was shown to Dr. Schultz, who reported as follows:

"*Gross.* Resected segment of small intestine 5 cm. long. At its middle there is a rather sharp constriction 2 cm. in external diameter, in which the external surface for half the circumference is formed by a slightly raised, firm, pale area 1 cm. wide in the longitudinal axis of the gut. Above the constriction the gut is 4 cm. in diameter; below it, 2.5 cm. In the region of the constriction a pale, rather dense, well-defined, mushroom mass projects into the lumen; this is 2 cm. wide in the long axis of the gut. (See Fig. 2.)

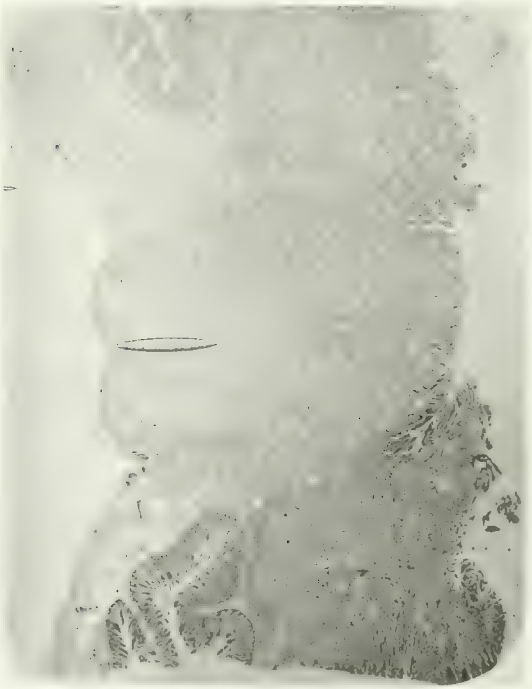


Fig. 2.

"*Microscopic.* Both above and below, the transition of normal mucosa to tumor is sudden and sharp. The tumor is composed of stroma of variable density, in which are embedded atypical glandular alveoli. The latter vary in shape and in size; many are branched, and in many the epithelium is infolded. The epithelium in general is of the intestinal cylindrical type, but in many alveoli it is more atypical and polyhedral. Mitoses are numerous. The entire intestinal wall is penetrated by the tumor mass, which has replaced muscle and the other constituents of the wall." (See Fig. 3.)

BIBLIOGRAPHY

Gramen, K. *Hygiea*, Oct., 1916, lxxix, 1015.
Bevan, A. D. *Surg. Clin.*, Chicago, June, 1917, i, 471.
Lichty, J. A. *N. York State J. M.*, Nov., 1918, xviii, 433.
Head, G. D. *Am. J. M. Sc.*, Feb., 1919, clvii, 182.
Judd, E. S. *Lancet*, April, 1919, xxxix, 159.
Deaver, J. B. *Am. J. M. Sc.*, April, 1920, clix, 469.
McGuire, E. R. *Am. Surg.*, Nov., 1920, lxxii, 600.
Ibid. *Arch. de mal. de l'appar. digest.*, Feb., 1920, x, 419. Abs. May, 1920, lxxiv, 1353.
Herman ,N. B. *Am. J. M. Sc.*, Jan., 1921, clxi, 111.
Ewing, J. Neoplastic Diseases. Philadelphia, 1922.

DISCUSSION

Dr. Moore. I enjoyed Dr. Portis' presentation very much. Certainly these cases of malignancy of the small bowel are sufficiently rare to be of unusual interest, and yet they do occur as a definite thing, and therefore we must, as roentgenologists, be on the lookout for them. Personally, I have seen two cases of malignancy of the small bowel, with location of growth high in the duodenum. One was an adenocarcinoma. There was a six-hour retention in the stomach and marked dilatation of the duodenum proximal to the growth.

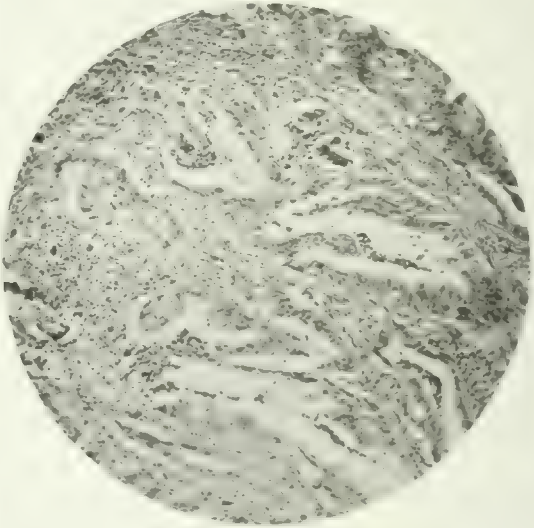


Fig. 3.

The second case was a growth situated in the duodenum, but close to the jejunal angle, and caused no obstruction in the stomach. However, it caused a marked retention of the six-hour meal in the small bowel proximal to the growth, and there was extreme dilatation.

Both of these cases were operated on. The first case was an adenocarcinoma of metastatic origin. The second case was operated on and left the year following.

The thing that impressed me was the extreme degree of prostration in those two cases. It seemed to me that the prostration was considerably in excess of the complaint of the patients as to their length of symptoms and their discomfort and blood picture, the anemia not being particularly marked in either case.

Dr. Jaches. While I appreciate the compliment the chairman has paid me, I really do not know why he asked me to discuss this paper, except, perhaps, that he wanted to keep me indoors so that I could sit here and enjoy the presentation of Dr. Portis.

Personally, I have seen no such case, to the best of my recollection. The only lesion of the smaller bowel which caused dilatation and almost presented a picture similar to the one shown by Portis, was a type that he excludes in his paper—one that occurs in the cecal area.

I am glad, however, to have heard this, because, although the condition is very rare, we will nevertheless be on the lookout for it; and we can never tell when a condition which occurs, say once in ten thousand cases, will strike us very hard.

I simply want to thank Dr. Portis for having given me an opportunity to listen to his paper.

Dr. LeWald. The following 4 cases occurred in the service at St. Luke's Hospital: One was in the second portion of the duodenum and caused obstructive symptoms; that was an adenocarcinoma. It was simply explored and the diagnosis confirmed. Another case was operated on and the tumor in the jejunum resected. I do not have complete notes of the final outcome.

Another case, also in the jejunum, caused partial obstructive symptoms. The fourth case was one that had been operated on by another surgeon, who had simply performed an intestinal anastomosis to the abdominal wall, and the question came up as to where the connection had been made. I injected sodium bromide solution 20 per cent through the fistula and made a diagnosis of jejunal fistula. If you are in doubt about what to use in examining a sinus, you may use sodium bromide solution with perfect satisfaction. It acts as a cathartic if it reaches the bowel and is promptly eliminated. It is the same solution we use in obtaining a pyelogram.

Dr. Portis (closing discussion). I am very glad to hear Dr. LeWald report that he has found such cases. As Dr. Jaches has said, any one of you might unexpectedly be confronted with a case of this type. They are very easy to diagnose.

Two cases which I saw I recognized very quickly, largely after excluding the stomach by laboratory and *x*-ray methods. The *x*-ray evidence is clean cut. When you find occult blood in the stool, and you have a picture of the individual I described, you can fairly definitely assume that you are dealing with a possible malignancy. At least it is surgical, and if the surgeon should not find malignancy, there still is definite indication for operation, and you are wise in advising it.

ROENTGEN GASTROINTESTINAL STUDIES OF PATIENTS WITH CHRONIC DEFORMING ARTHRITIS*

BY R. G. TAYLOR, M.D.

Hospital of The Good Samaritan

LOS ANGELES, CALIFORNIA

THIS subject was approached originally from the surgical side, and, so far as we are personally concerned, has been studied largely from that viewpoint, due to the fact that most of the work that we have done has been done for surgeons.

Starting with the proposition that the cause of chronic deforming arthritis is an intestinal infection, probably, more specifically, a perverted bacterial flora in the intestines with secondary joint infections, these roentgen studies have been pursued. It is recognized that the theory of the gastrointestinal origin of this type of arthritis is not universally accepted. Nevertheless, holding this theory, we have made the gastrointestinal studies with it as a basis.

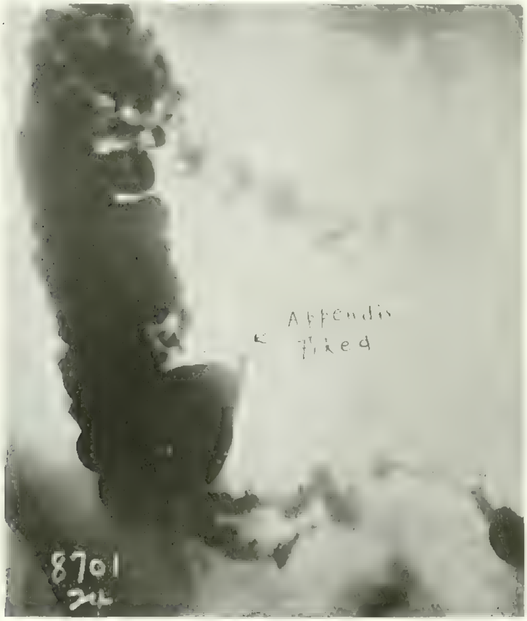


FIG. 1. Case8701. Twenty-four hours p.c. Mobile colon, except tip of cecum which is fixed by appendix, adherent, high up inside of ilium. Pouching downward of movable colon forms pocket, which fails to empty in seventy-two hours. Findings confirmed at operation.

These studies have been made by giving a single meal, examining the upper tract, and then at six, nine, eleven, and twenty-four hours making observations, chiefly with the screen, but with some films for record purposes. Thereafter observations are made each twenty-four hours until the final disposition of the meal is determined.

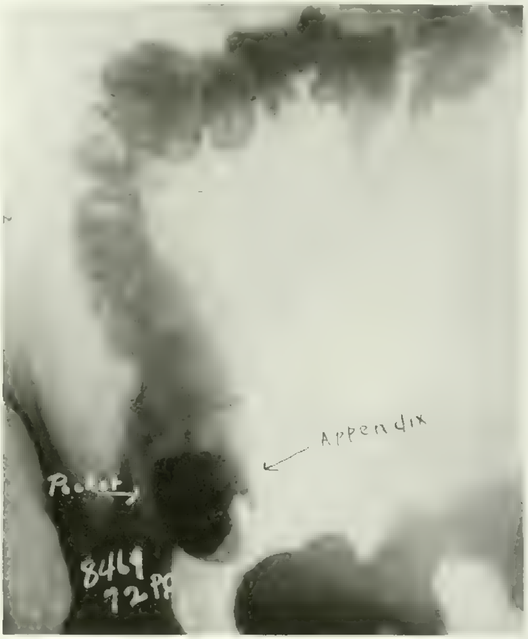


FIG. 2. Case 8469. Seventy-two hours p.c. Deformity of cecum caused by retrocecal adherent appendix making pocket in cecum which does not empty in seventy-two hours. Findings confirmed at operation.

An enema is given if the distal colon is not fairly well visualized, or if there is anything noted with the meal suggesting pathology.

In a general way, the things we have observed have been: First, the majority of these patients have a certain type of colon characterized typically by its abnormal length and abnormal mobility. Second, practically all the cases that have become chronic show so-called surgical lesions in the right colon, or in the ileum, or in both. Third, these lesions consist of adventitious bands similar to Jackson's membrane, involving the colon, usually above the ileocecal valve, and involving occasionally the ileum, producing the so-called Lane kink and other less typical fixations, or chronic appendicitis, or the results of an acute inflammatory process in the appendix with adhesions and fixation of the cecum and appendix to surrounding structures, notably the ileum and right colon itself (the appendix is frequently retrocecal), or post-operative adhesions following removal of the appendix.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a later number of the JOURNAL.

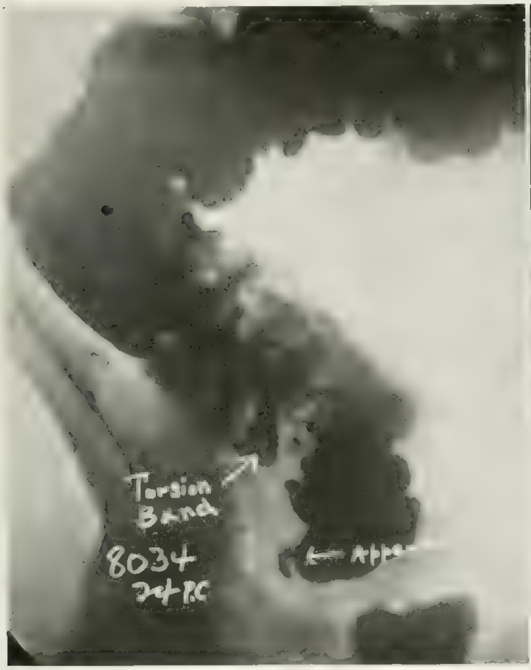


Fig. 3. Case 8034. Twenty-four hours p.c. Cecum descending into pelvis with band making torsion in this position above ileocecal valve. Colon distal to band rotated, showing appendix on the right of cecum.

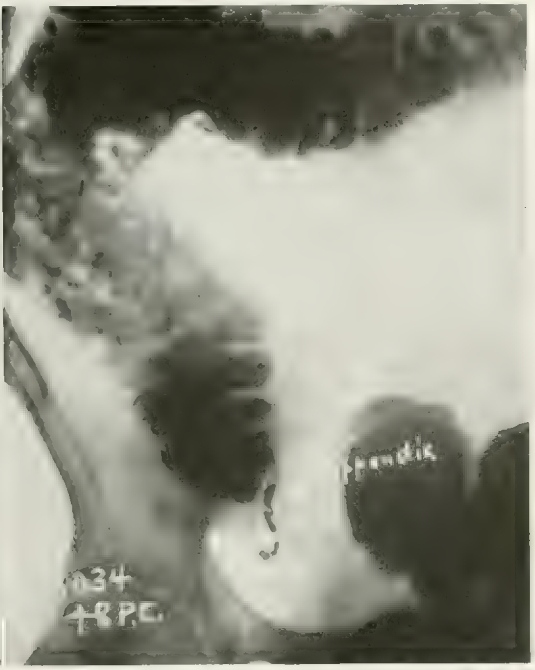


Fig. 4. Case 8034. (Same case as in Figure 3.) Forty-eight hours p.c. Cecum raised out of pelvis. Tension on band relaxed relieving rotation. Appendix in normal position on the left and normal outline of colon. Findings confirmed at operation.

We believe the adventitious bands are usually congenital or are developmental processes, the result of the abnormal mobility of the right colon. Some of them may be the result of local inflammatory processes in this region, chiefly from the appendix; but there are apparently two fairly distinct types of cases: those in which the appendix and the results of its inflammation are the chief factor, and those in which the adventitious bands usually showing a little higher in the colon are the chief factor.

The presence of these bands and adhesions results in a crippling of the intestine, which is evidenced roentgeno-

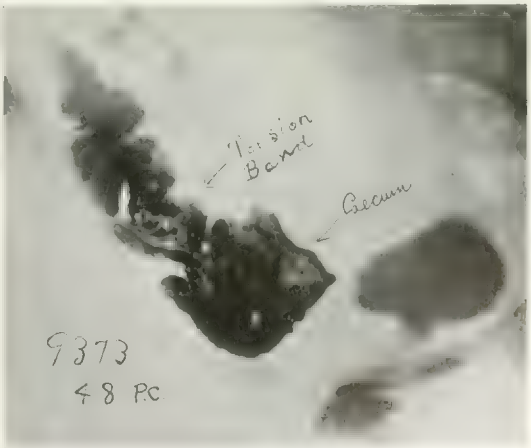


Fig. 5. Case 9373. Forty-eight hours p.c. Rotation of cecum by band when descended into pelvis. Twist of bowel shown by partially filled rugae. Findings confirmed at operation.

logically by certain deformities in the barium shadow and evidence of torsion or twisting or kinking of the gut with resulting constriction; also in a fairly large percentage of cases by a definite local stasis proximal to the lesion.

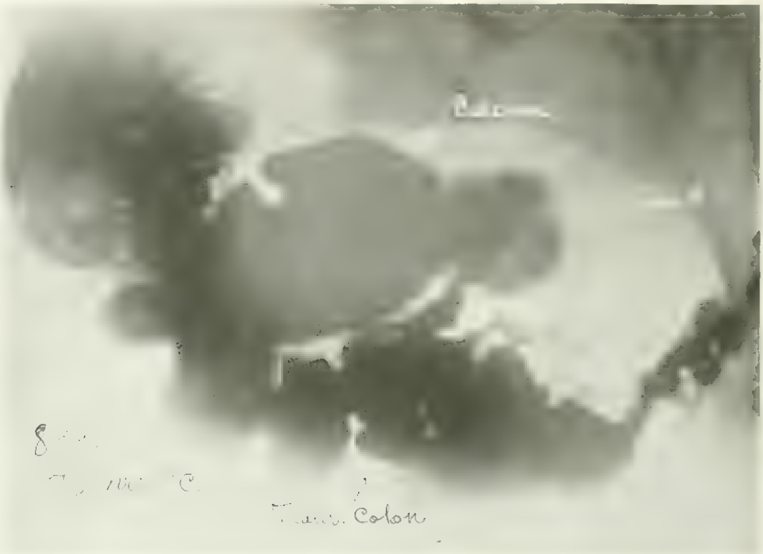


Fig. 6. Case 8993. Seventy-two hours p.c. Anomalous position of cecum at center line in the pelvis; very movable, low hepatic flexure and transverse colon. Torsion in the ascending colon about its middle with practically no emptying at seventy-two hours. This is probably congenital over rotation without fixation at the flexure. Findings confirmed at operation.

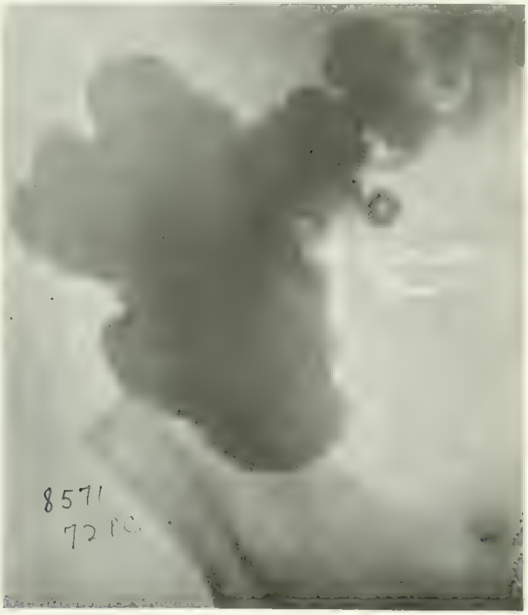


Fig. 7. Case 8571. Seventy-two hours p.c. Almost entire retention of meal in right colon and hepatic flexure. Constricting band in transverse colon, just distal to flexure. Findings confirmed at operation.

In connection with the theory of intestinal infection it seems reasonable to believe that a local stasis distinctly favors infection and perversion of the normal flora. This has been well demonstrated in other portions and organs of the body. The interest of the roentgenologist consists in the demonstration of the lesions which probably are responsible in most cases for the crippling and stasis.

Granted that there is an infection, and that there is a crippled portion of the intestine, it would seem reasonable to assume that the crippling of the intestine, especially if it produced local stasis, is a factor in the continuance of the infection, and certainly must be taken into consideration when an attempt is made to bring about a normal condition. We therefore believe that these lesions must be done away with before marked permanent improvement in the local condition can be expected. A certain percentage of these cases that show some crippling but no actual stasis would seem to offer a chance for pure medical treatment; but the others are distinctly surgical.

We believe that the roentgenologist can, in a general way, segregate these two classes from his findings, and also that he can, with a reasonable amount of experience and observation, in the surgical cases, tell the surgeon the type, location, and kind of lesion to be expected, and give him some idea as to the degree of normal function being performed by the bowel.

A check-up of the roentgen findings with the operative findings in between 30 and 40 cases shows a very gratifying percentage of correct diagnoses, the chief place of error being in the ileum, pathology being ordinarily found there when indicated by the roentgenologist, but also occasionally being found when not shown by him; error in reference to the colon and cecum being practically negligible.

The results of the treatment of these cases are not to be included in this paper except to say that with proper roentgen selection a reasonable proportion of the so-called non-surgical cases have shown satisfactory and gratifying improvement. Of the surgical cases, about 50 per cent of those whose operation is remote enough to determine the final result, have shown practically complete arrest of the disease. The other 50 per cent are graded from "improved" to a few that have shown no improvement. The results have been gratifying enough in this practically hopeless type of disease to make us feel that we are warranted in further pursuing this subject and developing its diagnosis and treatment.

The purpose of this paper is to call again the attention of roentgenologists to the importance of roentgen studies in these cases, to the value of the findings, and to the very distinct and easily demonstrated types of lesions that are almost invariably found in the gastrointestinal tracts of these patients; also to impress on the internists who are interested in treating this disease with the intestinal infection theory of causation as a basis, the futility of attempting to get permanent results in the cases which show frank surgical lesions.

It is to be noted that this type of long mobile colon, with adventitious bands, or with bands and adhesions due to past or present appendix inflammation, has been found in many patients who do not show arthritis. However, a careful review of these non-arthritic patients shows them invariably to be subject to symptoms that are most easily explained as being the result of an intestinal infection. As to why these patients do not have arthritis and others do, is a matter that is still unsettled and under discussion. We hope some day in the near future to report the studies on these patients.

With regard to the routine examination of patients in the manner above outlined, we have tried numerous short-cuts, all of which appear to have been lacking in some essential, and have been discarded. We have come to the conclusion that the additional and more accurate information gained well repays the roentgenologist for the extra work involved.

A COMPARISON OF CLINICAL AND ROENTGENOLOGICAL OBSERVATIONS IN PULMONARY TUBERCULOSIS

BY FRANK S. BISSELL, M.D.

Roentgenologist to the Minneapolis Clinical Association

MINNEAPOLIS, MINNESOTA

INTRODUCTION

THE conviction that close cooperation between the lung specialist and the roentgenologist are essential in the diagnosis of pulmonary disease has led the writer to enlist the assistance of Dr. W. J. Marcley in this study. Out of 265 cases examined for the U.S.P.H.S. during part of 1919 and 1920, 114 cases, in which a satisfactory examination had been completed by both of us, were selected and the result of the study tabulated.

Total Number of Cases in Series	114
R. Positive—C. Positive	59
R. Positive—C. Negative	0
R. Negative—C. Negative	15
R. Negative—C. Positive	4
R. Indeterminate	36
Analysis of Indeterminate Group	
Total	36
Called probably tuberculosis	26
Clinically positive	23
Clinically negative	3
Called probably not tuberculosis	10
Clinically positive	6
Clinically negative	4

It is perhaps unfortunate, from a scientific point of view, that any diagnosis of tuberculosis in its earliest stages may justly be questioned on the ground that there is no single infallible test, uninfluenced by the judgment of the examiner, by which the correctness of such a diagnosis may be proved. Nevertheless, careful observation for a sufficient length of time, skilful elicitation and conservative interpretation of physical signs, study of pulse and temperature curve and the determination of sensitiveness to tuberculin administered subcutaneously, will produce a mass of evidence which should be acceptable in any medical court.

The cases reported herein were checked by clinical studies as outlined above, and by independent roentgen-ray observations. A similar study with very similar results was made in collaboration with Dr. E. T. F. Richards of St. Paul, in 1913, and published in the AMERICAN JOURNAL OF ROENTGENOLOGY.

ROENTGEN TECHNIQUE

It seems necessary to emphasize repeatedly two important considerations, in the hope that they may eventually find a place in all criticism of the roentgen diagnosis of pulmonary disease:

1. That the lung roentgenograms, from which safe deductions may be drawn, must be of the best quality, prepared according to a standard technique.

2. That much intensive study and large experience are quite as essential to intelligent interpretation of roentgenograms as they are to other special types of medical procedure.

Important factors in technique are:

(*a*) Position of patient (vertical, breast against plate, scapulae thrown outward).

(*b*) Tube distance and shift (accurately correlated).

(*c*) Exposure time (not exceeding one-tenth second).

(*d*) Tube (fine focus).

(*e*) Accurate time development.

THE ADVANTAGES OF COOPERATION

It is indeed disheartening in this day of medical advancement, to observe so frequently men without sufficient experience to appreciate the pitfalls, attempting to interpret lung roentgenograms which would be wholly unreadable to the most experienced. The writer would not discourage the laudable efforts of those interested in lung diseases to familiarize themselves with *x*-ray diagnosis, but would merely emphasize the danger of relying too much upon their own roentgenological deductions until they have given the subject as much or more study than they have found it necessary to devote to other diagnostic procedures.

The roentgenologist with his greater experience in the interpretation of lung stereograms could be of much greater assistance to the clinician if he were more in the latter's confidence. There is a well-marked disposition on the part of most clinicians to withhold (consciously or inadvertently) clinical data in their possession from the roentgenologist. From a practical standpoint this is ill-advised, since it may lead the roentgenologist into avoidable error, and this in turn, may mislead the clinician himself. The roentgenologist should be treated as any other consultant, and supplied with all information available. He is then in a position to confirm, refute, or supplement the clinical findings.

When the history of the early development of this work has been written, the name of Kennon Dunham will stand preeminent as that of the one who has done most to place the interpretation of lung stereograms upon a pathologico-anatomical basis. In our opinion, however, too much reliance has been placed upon the so-called "fan" or "cone." While this is, doubtless, a sign of great value when present, many correct diagnoses of early pulmonary tuberculosis can and must be made without its aid. We stress this point because many workers in this field have been led by Dunham's emphatic statements to search their stereoscopic plates only for the cone, and not finding it have discredited the roentgen method by failing to make the correct diagnosis. Dunham's latest publication[1] is an admirable piece of work, in which there is everything to commend and little to criticize. It is one of the most noteworthy contributions to the medical literature of our day. It is significant that in this article, he does not stress the value of the "cone" as he has done in previous papers.

ROENTGENOLOGICAL OBSERVATIONS

A careful review of a large series of known tuberculous cases of many different types and in various stages of development has failed to show a single instance in which there were not abnormal lung markings in the periphery of the upper lung field beyond the distribution of the terminal bronchi. It would seem, therefore, that for practical purposes at least, the rule might be laid down that a negative diagnosis is indicated when the lung parenchyma within this part of the lung field is free from all evidence of infiltration. While it is true that tuberculosis may chiefly involve the lower lung fields, this study seems to indicate that there are always some signs of the disease within the area described. These tuberculous lesions take the form of fine tubercle-like shadows, sometimes in the form of small conglomorate patches, and sometimes not. If the disease is active, the lesions usually have a cloudy appearance, and there is no perfectly normal lung area between them and the hilus. If, on the other hand, the disease is arrested, healed, latent, or of the concealed type, these patches are less cloudy in appearance and the lung area around them appears relatively normal. There are a few other pathological conditions which produce changes similar to these in the upper lung fields. Jarvis[2, 3] has proved their occurrence in marblecutter's disease. These exceptions to the rule make the positive diagnosis somewhat less reliable than the negative, but experience in recognizing the differences in the character of these various shadow formations minimizes the danger of error. The literature upon this subject contains frequent references to peribronchial infiltration, the inference being that these are somewhat characteristic of tuberculosis. Our observations lead us to conclude that peribronchial infiltration is much more characteristic of other infections or bronchial irritants and that they should receive little consideration in the diagnosis of tuberculosis. A certain type of hilus thickening frequently associated with calcareous deposits has some contributory value, since it indicates a past tuberculous infection which may have become reactivated. Evidence of fibrosis may be accepted as pointing to a tuberculous process when it occurs in the upper lung fields or when there are other signs more or less suggestive of that disease.

CAVITATION

Tuberculous cavities may usually be recognized by dense annular shadows, within which normal lung markings cannot be seen. Patches in the lung with absolutely dense centers, indicating a caseating process, are usually present with such cavitations. The cavity of bronchiectasis is differentiated by its thinner wall and more cylindrical contour. Pulmonary abscess, theoretically, cannot be differentiated from a filled cavity, but the latter is a rare finding in the study of roentgenograms. The small circumscribed pneumothorax is difficult to differentiate from a cavity situated near the pleura, but this again is a rather uncommon location for a tuberculous cavity.

DETERMINATION OF CLINICAL ACTIVITY

Our statistical observations seem to indicate that the roentgen method is of great value in determining the degree of activity of those cases in which tuberculous lesions are present. In those cases diagnosed inactive the subsequent history or course of the disease agreed as a rule with the *x*-ray observations. Cases diagnosed as probably active showed a somewhat larger percentage of error, the evidence of activity probably being due to mixed infection. It is here that clinical evidence, as shown by temperature curve and case history, is of the greatest value. Our roentgen reports show an increasing number of cases classified as tuberculous, but with the question of activity indeterminate. This is because we have come to believe that the question of activity can usually be determined by clinical evidence, and that the province of the roentgen-ray examination is rather that of determining the site and extent of tuberculous lesions, presence of complications or the complete absence of clinical tuberculosis.

It should be borne in mind that the more characteristic signs of early tuberculosis are probably caused by lymphatic engorgement and local congestion, and hence will disappear as the process becomes inactive.

A diagnosis of clinical tuberculosis, based upon the presence of old tuberculous lesions without evidence of recent activity, tends to discredit the roentgen method.

ROENTGENOLOGICAL PROGNOSIS

In a previous paper, "Concerning a roentgen conception of pulmonary tuberculosis,"[4] an attempt was made so to classify various types of tuberculosis from a roentgen standpoint that roentgen reports might be of greater value in establishing a correct prognosis. Briefly stated, the various factors upon which prognosis could be based were:

1. The type of infiltration (either discrete or conglomerate).
2. The extent of lung involvement.
3. The presence of old healed lesions in other parts of the lung.
4. The amount of fibrosis.
5. The presence of cavities and areas of caseous pneumonia.

Thus in type A, so-called concealed tuberculosis, the prognosis is favorable as to life, but less favorable as to complete recovery of normal health.

Type B is more frank tuberculosis with typical clinical history, with marked fibrosis and no cavitation. In this type, prognosis is favorable under proper management.

Type C represents those cases with an early tendency to cavitation, in which there are massive conglomerate shadows in the roentgenogram indicating the presence of caseating pneumonias. This is the most unfavorable type from the standpoint of prognosis.

Type D, healed tuberculosis, shows the characteristic scars, broken linear markings, the pleuritic cap, the calcification, etc. It is thus seen that stereo-roentgenograms of the lungs, when properly studied, are of great value in arriving at a prognosis.

While the roentgenologist cannot, with conservatism, venture a prognosis in a given case, he may aid the consultant by emphasizing those factors in the report which are a direct indication of the probable course of the disease. Thus a simple diagnosis of fibroid tuberculosis is insufficient, unless qualified by a full description of all observations including cavitation, caseation, disseminated and discrete lesions, and their distribution.

Such a classification as this one serves the further purpose of clearly pointing the way

Type A

Roentgenological	Clinical	Pathological
1. Infiltration, peripheral	1. Poor nutrition. Exhaustion with slight exertion	
2. Tendency to unilateral involvement	2. Occasional slight temperature upon exertion	
3. Limited areas of involvement	3. No physical signs	
4. Areas of previous involvement indicated by increased fibrosis	4. Reaction to subcutaneous tuberculinfocal, general, or both	
5. Progression from one area to another, shown by observations over period of years	5. Favorable prognosis	
6. Absence of cavitation		
7. Absence of massive or conglomerate infiltration		

Type B

Roentgenological	Clinical	Pathological
1. Fine soft shadows of infiltration both peripheral and peribronchial	1. Temperature curve	1. Infiltration
2. Direct extension to hilus	2. Intermittent physical signs	2. Fibrosis
3. Characteristic distribution in 1st and 2nd interspaces (preferably right)	3. Loss of weight with intermittent gains	3. Pleuritic thickening especially over apices
4. Dunham fan more common	4. Prompt tuberculin reaction	4. Noncaseating
5. No cavitation	5. Sputum frequently negative	5. Absence of amyloid changes
6. Marked fibrosis	6. Favorable influence of climate	6. Absence of cavities
7. Progression to general involvement of one or more lobes	7. Infinitely chronic	
8. Localized density over apex (one or both)		

Type C

Roentgenological	Clinical	Pathological
1. Early signs similar to Type B	1. Physical signs typical and early	1. Infiltration
2. Massive conglomerate shadows make early appearance	2. Hemoptysis often occurs	2. Caseation
3. Marked tendency to cavitation	3. Bacilli in sputum early and constant	3. Cavitation
	4. Progression unremittent	4. Amyloid
	5. Unfavorable response to climate changes or sanitarium treatment	5. Fibrosis
	6. Frequent presence of focal infection of tonsils or teeth (especially the former)	

Type D

Roentgenological	Clinical	Pathological
1. Absence of characteristic parenchymal shadows and of Dunham fan	1. No clinical signs	1. Calcification
2. Areas or nodules of great density (calcification)		2. Fibrosis
3. Broken lung fields (fibrosis)		3. Thickened pleura
4. Evidence of pleuritic "cap" over one or both apices with localized extension of fibrosis-like shadows into lung field		

to complete cooperation and understanding between the roentgenologist and the clinician.

A little knowledge of the clinical history will not lead the roentgenologist, if he is trustworthy and experienced, into the error of reading observations into his plates. On the other hand, there are so many times when he may properly say, "Here is the pathology—what is the history?"

Then, too, such knowledge always serves to arouse a keen interest in the case, thus sharpening his powers of observation. The art of diagnosis has become so complex with the development of new methods and minor specialties that the attainment of the best results demands the free interchange of thought and the closest coordination of ideas.

THE ROENTGEN REPORT

Since the communication between the roentgenologist and the clinician is usually a written one, a concise terminology based upon a clear conception of the disease is an essential requirement. While observations may be described in terms of variable densities, conclusions must be a translation of these observations into pathological terms. With such a pathological conception established, an opinion as to the actual disease present is a logical sequence. Such an opinion may be positive in character when observations have been sufficiently characteristic to justify the opinion that a tuberculous lesion is present. The opinion may be qualified by a statement as to the probable activity or inactivity of the disease, and a suggestion as to prognosis.

A report may be negative in character, and this should mean that there is no evidence in the roentgenogram of pathological change in any sense characteristic or even suggestive of tuberculosis.

The report may be indeterminate, which should mean that there are changes present which are neither sufficiently characteristic to justify the conclusion that they are due to tuberculosis, nor clearly enough of negative value to warrant a negative diagnosis.

An indeterminate roentgen diagnosis may very properly be used with considerable frequency, but should not be employed as a subterfuge, and should always be fully explained in the body of the report.

A re-study of the plates in the series of indeterminate cases has convinced the writer that most of them may be placed with accuracy in either the positive or the negative group. In fact, it was found that the observations described in the body of the report usually gave a direct indication of the group to which the case belonged.

Tubercle bacilli were later found in the sputa of three of this group, but a re-examination of the plates showed abundant and characteristic evidence of tuberculosis. This shows that the error was due to hasty observation and carelessly drawn conclusions on the examiner's part, not to a fault in the method.

THE NEGATIVE REPORT

The negative report has for some reason not been given the high place in the ensemble of diagnostic data which it deserves. Such a report, when made by a competent roentgenologist, under favorable conditions, may well be accepted as conclusive, even though all other signs seem to indicate pulmonary tuberculosis. While no effort should be spared to exclude the ever-dangerous element of human error, it is doubtful whether a diagnosis of pulmonary tuberculosis is ever justified in the face of repeated negative roentgen-ray findings.

A careful review of our series of plates in conjunction with the subsequent histories of patients has so far failed to reveal any instance where the stereoscopic plates were entirely negative, and the case later proved to have been pulmonary tuberculosis.

CASE REPORT

Male. Entered St. Mary's hospital for study on Feb. 5, 1921. Had been in service since Jan., 1918. Had influenza in Sept., 1918. Quite ill for ten days and coughed up clots of blood. Has had slight cough since that time. No loss of weight. No fever at any time, except first three weeks of Jan., 1921, when he noted temperature of 99°F. or over. Tires readily. Occasional night-sweats in Jan. On Jan. 27th, "without warning coughed up about a cupful of clear blood" followed by expectoration of small amounts. Following day, two hemorrhages, one large amount, one smaller. Remained in bed until coming to the hospital.

Physical examination by Dr. Alexander Josewich. Chest. Patient well nourished and developed. Head and neck negative. Heart normal. Lungs: Upper left, moderate dullness, bronchovesicular breathing and typical indeterminate rales.

Diagnosis. Tuberculosis, pulmonary, chronic, active. Upper lobe left.

ROENTGEN REPORT FEB. 9, 1921

Observations. Slight diffuse relative density over the left lung field. No evidence of active or recent pulmonary tuberculosis. Dense band across left lung field. Right lung negative.

Conclusions. Possible pleuritic thickening (adhesion or thickened interlobar pleura). Negative as to tuberculosis.

Following this examination, the patient was sent to a tuberculosis sanitarium in the Southwest, thence to Washington for further study, and later to California, where he was in a tuberculosis sanitarium for several months. Although many sputum examinations were made, tubercle bacilli were never found. On Mch. 15, 1922, the patient had another small hemorrhage and reported for another examination on Mch. 16th. At this time, physical signs were found in the upper left lung field more marked than on previous examination. Stereoscopic plates were made and read as follows:

"There is no roentgen-ray evidence to support a diagnosis of tuberculosis. Whatever changes are present in the lung field are at the base, chiefly on the left side, and there certainly is nothing upon which one can base a diagnosis of tuberculosis, from an *x*-ray standpoint."

Death occurred in an anginal attack on Mch. 18, 1922, and the report of the autopsy made by Dr. Carl A. Danielson is as follows:

"The right pleura had a number of fine adhesions from top to bottom, which could be broken up by the hand, thus freeing the lung. The left pleural cavity contained one large band of adhesions about the middle part of the upper lobe and the lung was freed from it with difficulty. This part of the adhesions apparently constricted this portion of the lung so that it was more solid. That is to say, it would not crepitate as readily as the rest of the lung. The apices of both lungs were free. The left lung, near the hilus, was in a state of chronic passive congestion. There was no evidence microscopically of tuberculosis, either active or healed, though I am not certain but that Dr. Bell may find something in the specimen sent down.

"There was a beginning atheroma of the aorta, and the coronary arteries were sclerosed. The cause of death was thrombosis of the left coronary artery.

* * * * * * *

"Today I have a letter from Dr. Bell with the report that there is almost a complete closure of the left coronary artery. The lungs show a little subpleural scar tissue. There is no evidence whatever of tuberculosis."

INDETERMINATE REPORT

About 20 per cent of our cases are classified as indeterminate on the ground that there are atypical changes in the lung fields which render a negative diagnosis inadvisable and a positive diagnosis dangerous. Certain cases of chronic pleurisy in which there is, or has been, an exudate, and in which the entire lung field appears abnormally dense on account of pulmonary infiltration, fibrosis or induration of the lung tissues, must be classified as indeterminate, since it is impossible with these changes present to exclude tuberculosis.

Then there are the postinfluenzal infiltrations, streptococcus bronchopneumonias and their sequelae, such as bronchiectasis, which must occasionally be classified as indeterminate with respect to tuberculosis.

POSITIVE ROENTGEN REPORT

In rendering a positive diagnosis of pulmonary tuberculosis, based solely upon roentgen evidence, one is beset with danger on every hand. A pulmonary infarct associated with bilateral infiltration may not even be considered, and its close resemblance to an active tuberculous process makes the slip easy and the fall hard.

There are the passive congestion of chronic heart disease, the so-called dust inhalation diseases and the streptococcus infections mentioned in the previous paragraph which must be carefully borne in mind, and if possible, differentiated; however, if reasonable care is taken in preparing and interpreting lung roentgenograms, and if the interpretation is founded upon broad roentgen experience and pathological knowledge, the positive roentgen diagnosis of pulmonary tuberculosis will be correct in a large percentage of cases.

This paper should be received as supplementary to certain others published by the writer during the past ten years. There is no attempt to present any new material, but merely to emphasize certain conclusions which time and experience have strengthened:

1. That cooperation between roentgenologist and clinician are highly important in the diagnosis of chronic lung disease.

2. That the relative values of various diagnostic procedures employed for the recognition of early tuberculosis are as follows:

History and symptomatology
Roentgen study
Sensitization to tuberculin
Physical signs
Laboratory tests

The roentgen examination is placed second, because, while lesions may be demonstrated in the stereo plates of practically all cases, their exact significance is determined by the case history and the symptoms.

Again, the symptoms per se have great diagnostic value since experience has shown that the early symptomatology of tuberculosis is always suggestive.

Dr. Marcley regards the tuberculin test, when properly applied in small doses of tuberculin, as of great value. A high sensitization to tuberculin, conjoined with positive roentgen-ray findings, however slight, justifies a positive diagnosis. Our study indicates that the mere presence of positive signs in the upper lung field should not have too much weight in the diagnosis of pulmonary tuberculosis. While we have placed the laboratory examination last in the list, the work of Larson[5] at the University of Minnesota may elevate laboratory procedures to the head of the list. This, however, will require time for development and proof. The finding of tubercle bacilli in the sputum is a rare occurrence in early tuberculosis, and even when present does not absolutely prove the existence of pulmonary tuberculosis.

BIBLIOGRAPHY

1. Dunham, Kennon. A comparative study of the pathology and x-ray densities of tuberculous lung lesions. *Am. Rev. Tuberculosis*, June, 1921, v, No. 4, 278.
2. Jarvis, D. C. A roentgen study of dust inhalation in the granite industry. Am. J. Roentgenol., Oct., 1921, viii, 244.
3. Jarvis, D. C. Dunham's fans in a roentgen-ray study of granite dust inhalation. Am. J. Roentgenol., Oct., 1921, viii, 560.
4. Bissell, Frank S. Concerning a roentgenological conception of pulmonary tuberculosis. Am. J. Roentgenol., Oct., 1918, v, 468.
5. Larson, W. P. The agglutination reaction in the diagnosis of tuberculosis. *Proc. Soc. Exper. Biol & Med.*, 1922, xix, 359.

PULMONIC AND CARDIAC CHANGES FOLLOWING INOCULATION WITH FOREIGN PROTEIN

BY I. EDWARD LISS, M.D.

From the Pediatric Division of the New York Nursery and Child's Hospital; and the Department of Pediatrics, Cornell University Medical College

SCARSDALE, NEW YORK

I. ADULTS

THOSE of us who were doing intensive investigation of early pulmonary changes in the type of infection prevalent during the great pandemic, were struck by the prevalence of a high percentage of these cases showing parenchymal changes without symptoms and the almost universal involvement of the hilums in all cases, even when there were no subsequent pulmonary sequelae. Further study of these cases showed that mottling of mediastinal and bronchial root tissues still remained several months after the subsidence of all clinical signs. Lord, in his chapter on circulatory disturbances, states that "inflammatory hyperemia, too slight in degree to be termed pneumonia, may be seen in the course of influenza and typhoid fever." Localized and sometimes general pulmonary congestion occurs, as is well known, after injection of tuberculin. Pulmonary mottling is quite commonly seen after inhalation of certain substances, as in hay fever. This is not so much by reason of their mechanical trauma as by their anaphylactic import. In the routine *x*-ray examination of influenza cases, attention was drawn to a radiogram in which general mottling was of a different type from the usual case. Two changes were sufficiently great to warrant further investigation, with the following interesting history:

The patient had received the usual dose of 0.5 c.c. of triple typhoid vaccine (army), and within thirty-six hours he was prostrated, and developed headache, malaise, back pains, short irritable cough and temperature (not a rare experience). On physical examination there was increased dulness and bronchovesicular breathing, and a few indeterminate rales were found from the 4th to the 2nd interspace on the left side. Clinically, because of the epidemic, a diagnosis was made of influenza with possibly a bronchopneumonic process. The clinical findings and the history of inoculation made an absolute diagnosis seem undesirable. As was the rule at this time during the epidemic, the patient was immediately examined radiologically. The plates showed a localized area of increased density from the 4th to the 2nd rib on the left side, and as there were none of the characteristic diaphragmatic and cardiac reactions to which Honeij has called attention, we felt that a definite diagnosis of influenza was unjustifiable.

Within thirty-six hours the temperature dropped to normal and the chest cleared up completely. Subsequent radiograms showed that the process was much improved and mottling was almost absent. Following this finding, the next 8 cases inoculated with typhoid vaccine were examined radiologically before inoculation and forty-eight hours later. Seven of these cases were supposedly "normal" chests; the eighth was one of extensive and non-active tuberculosis. The following findings were obtained:

Not one of them failed to reveal increased density, either pulmonary or hilum. In 6, this was general in character; in 6, the apices were involved; in 2, the middle thirds of both lungs were affected; in 1, the bases were involved. In 6, the upper aspect of the hilum was distinctly enlarged and mottled. In 7, the middle portion of the hilum showed these changes, and in 7 the lower portion of the hilum. In 5, the heart showed slight pulmonic dilatation; in 4, it showed right-sided dilatation. In 6, there was distinct increase in the peribronchial markings. In 1 case there was an increase in the size and density of the mediastinum; and in 1, glandular enlargement of the left middle hilum.

These incidental findings are analogous to those observed by investigators in cases of laboratory animals whose death was due to anaphylactic phenomena.

INFANTS AND YOUNG CHILDREN. INFLUENZA GROUP

No.	Increased Density	Parenchymal Site	Heart Enlargement	Hilum	Remarks
1	General + +	Left perihilum Perihilum +++	+ −	Right hilum + +	
2	General + −	Middle-right Left perihilum	+ +	Both hilums + −	
3	General + −	Left perihilum	+ −	Left and right ?	Peribronchial type of increased density
4	General + +	Left perihilum ++ Right middle +	+ −	+ −	
5	General + −	Right apex	+ +	Both	Increased density limited to hilums and left apex
6	0	0	+ −	0	Only slight mottling of hilum present
7	0	0	0	0	No change observed
8	Slight General	....	+	Right Left perihilums	Heart only showed changes

DIPHTHERIA TOXIN ANTITOXIN GROUP

No.	Increased Density	Lobes	Heart Enlargement	Hilum	Remarks
9	Peribronchial + −	Right apex	0	Right	
10	General +	All lobes	+++	Left ++ Right +	Questionable cardiac lesion
11	General	Upper right	+	Both	Left-sided cardiac enlargement
12	Local	Left upper	(Slight) +	Right	
13	General	Right base	Left sided ++	Both	
14	?	Left lower	Right sided (?)	Right	
15	Local	Right lower Right middle	++	Both	
16	Local	Perihilum	+	Both	Upper mediastinal enlargement
17	Local	0	+ −	Both (rt.) +	
18	Local	Right upper	+ −	Right	
19	Local	Right upper	+ −	Both	Changes of upper mediastinum
20	0	0	Slight enlargement	+ −	
21	Local	Right middle Left upper	++	Both	
22	Local	Right upper	+	Left	
23	Local	Right lower	+ −	Right	
24	Local	Right upper	0	Right	

II. INFANTS AND CHILDREN

Further investigation of these phenomena, employing the same roentgenological technique, was carried out upon a group of infants numbering 24, of whom 16 had been prophylactically vaccinated with diphtheria toxin antitoxin. In this series the findings were essentially the same as in our adult group when typhoid vaccine was used.

As shown by the accompanying table, mottling was local or general and practically universal. In one case only the heart showed some reaction by dilatation.

The remaining 8 children were examined after prophylactic treatment with influenza vaccine. Here, too, our findings confirmed our conclusions drawn from the work with typhoid vaccine and diphtheria toxin antitoxin.

In cases of food idiosyncrasy, as demonstrated by positive skin and constitutional reactions, with or without pulmonary anaphylactic signs, we have been able to demonstrate this intrapulmonary change as a concomitant anaphylactic phenomenon.

SUMMARY

Here we have an investigation covering a group of 33 individuals varying in age, the larger percentage of whom, after injection of foreign protein presented definite pulmonary changes and, in a smaller percentage, cardiac changes.

THE X-RAY IN NEUROLOGICAL DIAGNOSIS: ITS SHORTCOMINGS AND POSSIBILITIES*

BY HUGH W. CROUSE, M.D.

EL PASO, TEXAS

THE difference in density of the tissues involved markedly limits the use of the *x*-ray as a diagnostic aid in the varied pathology of the central nervous system. Previous to the intraventricular or intraspinal injection of air by Dandy in 1918, the neurologist did not expect the radiologist to do more than eliminate or demonstrate the presence of bone changes in the skull or vertebræ, or calcareous degenerations within the skull proper.

A careful review of the literature of reported cases of brain tumor during the last five years shows that 3 per cent of the new growths within the skull contain ample calcareous degeneration which is radiologically demonstrable. There is another 2 per cent of lesions of the central nervous system interpretable from an *x*-ray angle. Such lesions consist of the osteophytes of the inner plate of the calvarium, located mainly in the frontal area; growths of the orbit, either of an osseous nature or of sufficient size so that pressure will thin the bony wall to a noticeable degree; tumors within the ethmoid, sphenoid or frontal sinuses which through pressure effect destroy their bony boundaries; and dural tumors which through pressure thin the calvarium or seek and secure circulatory connections with the diploë, producing diploic varices. Pathology of the hypophysis, according to the literature of the last three years, when carefully tabulated, using the Journal reports as a basis, furnishes another 3 per cent which correlatively can be diagnosed by the *x*-ray. The summary of these three types of neurological lesions gives radiology an 8 per cent direct diagnostic aid ratio. Ventriculography and spinal intra-arachnoid injections of air, through their indirect aid in density shadings, have brought the demonstration of and the location of intracranial and intraspinal lesions through the *x*-ray as a diagnostic method up to a fair 52 per cent, correlatively speaking.

Neurological diagnosis previous to the epoch-making use of air by Dandy was as follows: Given a story of persistent, intractable headaches, alone or accompanied by projectile vomiting, choked discs, labyrinthine symptoms, manifested by the existence of a non-normal nystagmus or vertigo, changed reflexes, psychic derangements, muscular incoordination, an *x*-ray demonstration as to the existence or absence of skull or vertebral structure change or presence of calcareous deposit, coupled with proper serological findings, and the neurologist would decide as to the existence of a lesion and its probable location.

Many scientific factors have been correlatively blended, to accomplish a semblance of accuracy in neurological diagnosis.

Epoch-making neurological diagnostic aids have arisen during the last decade and a half. Barany's observation in 1905 of a definite type and directed nystagmus accompanied by distinct vertigo when suppurative ears were douched with cold or hot water, led naturally to the present caloric test. Flourens, in 1825, made an excision of portions of the labyrinths of animals and noted that as a result this caused movements of the eyes and definite disturbance of equilibration. Purkinje, at the same period, noted that human beings when turned about, developed a nystagmus and vertigo. Meniere, Goltz, DeCyon, Von Stein of Moscow and Hogyes, a Hungarian, made definite studies along similar lines, the latter two contributing a valuable summary of the anatomy and physiology of the inner ear. All these observations were weighed, as well as Von Graef's pointing test in ocular palsy, by Barany, and the chair test of nystagmus,—the head in varied positions to utilize the anatomy of the semi-circular canals,—and the past-pointing vertigo syndromes of Barany came into existence, a veritable summary of several scientists' observations. The value of the Barany past-pointing nystagmus and vertigo manifestations in basilar and cerebellar-pontine fossa lesions has produced and is still productive of heated controversies between otologists as to its place in diagnosing tumors of the brain. A large part of this controversy between those interested in neurology is due to inadequate or lack of open-minded study of the Barany syndrome.

---

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922

Lesions of a developmental or accidental nature, about the pons or medulla, or along the individual or associative tract, pursued by the 8th nerve from nucleus to termination, are diagnosed through nystagmus and equilibration defects. Equilibration is an intimate association of three senses, namely, sight, muscle, and kinetic static. The utricle, sacculi and the three semicircular canals of the internal ear have been accepted as a separate and distinct organ, thus making two for the inner ear, the cochlea, the organ of hearing, the saccule, utricle and the three semicircular canals the organ of equilibration. Variation from the normal, secondary to the use of the caloric or Barany tests, gives the neurologist a neuro-otological aid that must be weighed in interpreting a possible pathology in the silent areas of the brain.

Acuity of vision may be unimpaired in early brain tumor, but the color sense is frequently decidedly encroached upon at an early period, particularly in chiasmic area lesions. Pituitary pathology promptly intrudes on the color sense. Internal hydrocephalus, by third ventricle enlargement compresses the chiasm, with the resultant effect of a rapid edema of the optic nerve disc. Communicating hydrocephalus, particularly the type that is produced as a result of intrapendicular or chiasmic cistern occlusions, intrudes on the chiasm with a resulting optic nerve change which is expressed in the choked disc of varied degree.

Berthold's studies in 1848 of the transplantation of a cock's testes; Addison's monograph in 1855 attributing a definite clinical syndrome to a diseased destructive process of the suprarenal capsule; Bernard's investigation of the hepatic function and demonstration of an internal secretion (glycogen as well as the external secretion, bile) led easily into a line of organotherapeutic interest, popularized by Brown-Sequard. Knowledge of disorders of the thyroid, a frequent etiological factor in lesions of the central nervous system, was given the light of day. This included the addition by Liegeois, sixty odd years ago, of the pituitary to the ductless gland groups and endocrinology. Cushing's epoch-making studies of the pituitary led to the recognition of the separate functions of the anterior and posterior portions of the gland. The careful summary of the objective and subjective symptoms, among which color-sense defects assume a prominent place, shows that the pituitary, not only in a direct but in an indirect sense, assumes a prominent position in the lesion of the central nervous system.

These rapidly scanned points bring to the elucidation of central nervous system lesions the aid, then, of the histologist, the physiologist, the ophthalmologist and the representative of a new branch in neurological diagnosis, namely the neuro-ophthalmologist. To the radiologist has been entrusted the chief place in demonstrating the presence or absence of lesions of the hypophysis. By utilizing the radiographic formula of Leri, which is (1) enlargement of the anteroposterior or of the vertical diameter of the sella turcica; (2) enlargement of the frontal sinuses; (3) irregularity of the thickness of the calvarium; (4) exaggeration of the external occipital protuberance: by blending with the above Paccini syndromes of variation of angles, the pathology of the pituitary is radiologically clarified.

Paccini uses a wax pencil and marks the skiagraph of the skull first at the nasion, second at the turcicon, a hypothetical point placed in the sella space where the imaginary long and short diameter lines intersect at right angles, and third at the akoustion, a point in the uppermost ovoid shadow cast by the external auditory meatus, connecting nasion to turcicon, turcicon to akoustion. He then notes the degree of angulation which such lines assume. The age, sex and race of the patient must be considered, along with the variation of angulation. It is insisted that one will thus be able to recognize the finer changes of pituitary disease, more especially the changes involving secretion, or better, physiological function. This remains as yet a debatable point. There is perhaps a marked value, yet there is needed a decided degree of careful investigation and innumerable observations to make these assertions absolutely tenable. By blending Leri and Paccini points, interpretation of the endocrine neurological trouble, acromegalia, as well as hypofunction of the pituitary, can be radiologically demonstrated.

Dandy's work for you, as well as for us, your neurological confreres, has been, speaking in a diagnostic as well as localizing sense, epoch-making.

"Jacobeaus used the therapeutic insufflation of air as far back as 1909, and ten years later tried out the diagnostic possibilities on a case of spinal tumor. In an article which appears in the *Acta Medica Scandinavica* for Dec. 5, 1921, lv, 6, he reports in great detail 3 cases including the proceedings. Another Scandinavian, Josofson, reports a single personal case, and apparently these 4 make up our knowledge of the successful cases."*

Jacobeaus, while preceding Dandy in the use of air in subarachnoid spaces, failed to publish his investigations in the use of air in neurological diagnostic work. Pneumography of brain and cord is distinctly Dandy's device, safely bulwarked in the fortress of independent study and priority of publication. Other agents beside air should be considered. Hydrogen gas has a markedly increasing capacity of density contrast over air and is not irritating to the delicate structures of the cord or brain, but is not so accessible, hence will never be popularized.

The technique, proven safe in carrying out ventriculography and spinal intraarachnoid injection of air, has a few seemingly simple yet essential points. To neglect these points is so dangerous that it seems fitting to mention them in some detail. The first is a careful selection of equipment. With an ordinary 20 c.c. record syringe which has a two-way connecting tip such as is used in aspirating fluid from a chest, a couple of carefully selected platinum spinal needles, a reliable mercurial spinal manometer, and a small syringe for anesthetizing the skin and subcutaneous tissues, one is equipped to carry out the subarachnoid injection of air.

The intraventricular method needs, beside the above equipment, a knife, needles, artery forceps and a Doyen burr. Carefully prepare the scalp, then mark the same, either along Chiene's, Kocher's or LeFort's method of cranio-cerebral topography, locating the midpoint of the sagittal line. Then, if one accepts Kocher's plan, separately mark an anterior 80° point. Next, at a point 2 cm. either to the right or the left of this, mark the place for trephining. All this work can be done under local anesthesia. This point to the right or left of the anterior 80° spot of the sagittal point is fairly accurate for tapping the anterior horn of the lateral ventricles. The next important feature is the taking of the pressure of the fluid, whether from spine or ventricle, before any escapes, and measuring accurately the quantity removed. Atmospheric air has been proven clean. Its ordinary room temperature is satisfactory for injection. The force that should be used should be based upon the manometric readings. One should not insert a greater quantity of air than the amount of cerebral spinal fluid removed. The double spinal needle technique of Adolph Bingel is unnecessary. It is a dual mechanical insult to the dura. Drain all the spinal fluid that will escape. Have the head and shoulder of the patient 20 per cent higher than the lumbar region. Inject the air slowly. Disconnect the syringe now and then from the spinal needle. Wait a couple of moments, or until the ascending air has displaced the descending cerebral spinal fluid, the latter being carefully caught and measured. Repeat the injections of air as often as it is needed to secure a positive cessation of fluid flow.

---

* Editorial. Diagnostic Insufflation of Air into the Spinal Canal. *Med. Rec.*, Mar. 11, 1922, ci, 422–423.

The ventricular injection does not call for the use of a needle in each ventricle, although if careful equal exchange of air for fluid is maintained there is no danger, as has been proven, from removal of all the cerebrospinal fluid in the ventricles. Where the technique of double needles is carried out, one is used for fluid escape, the other for air entrance. The ventricles are tapped at two slightly separated periods. Fluid is permitted to escape after its pressure has been manometrically read, the head being turned so that the first tapping is of the superior ventricle. Then the lower ventricle is tapped, and the outflow of fluid from the lower needle sucks in air from the upper, ample to fill ventricles, and at an ordinary atmospheric room pressure.

This is the method used in hydrocephalic states of young children, whose fontanelles have not yet closed. It is through the outer angle of these, of course, that the tapping has been done. In the ventricular technique in adults one should not attempt tapping both ventricles unless one has developed a dry tap, a condition resulting from a tumor occluding the foramen of Monro or a compression of the ventricle one is attempting to drain, by a tumor in the adjoining tissues. Such a result should induce one to trephine and to attempt to tap the opposite ventricle.

Ventriculography beautifully demonstrates the internal, as well as the communicating type of hydrocephalus. Occlusions of the aqueduct of Sylvius or of the foramen of Magendie and Luschka, have differentiating *x*-ray points. Obstruction of the foramen of Luschka and Magendie gives a wide distention of all four ventricles and a practically dry spine. Stoppage of the aqueduct of Sylvius produces a wide dilatation of the lateral and third ventricle and an almost empty spinal arachnoid.

The occlusion of the cisterns, particularly the chiasmatica or interpeduncular cistern, is not alone accompanied by a high spinal fluid pressure, but when the phenolsulphonephthalein test of Heur and Dandy is given, the urine content in two hours may show as low as 8 to 12 per cent of phthalein instead of the normal 35 to 45 per cent. The physiological fact that four-fifths of the cerebrospinal fluid is absorbed from the cerebellar subarachnoid space, and one-fifth from the spinal neurolymphatic spaces has been well proven. The phthalein test but utilizes this fact.

Internal hydrocephalus needs distinctly a ventricular tapping. In communicating hydrocephalus the spinal injection of air is ample. The clinical story of an adult, when properly studied, leads to a fair pre-tapping interpretation as to type. In young children with open fontanelles the ventricular route is preferable. There is no part of cerebral roentgenological interpretation that demands a greater knowledge of the normal than ventriculography. The location, size and contour of the ventricles must be firmly fixed in the mind of the man interpreting the plate. Compression of one of the lateral ventricles by contiguous growth may be either in its body or in one of the horns. One should remember that the ventricle next to the plate in a ventriculograph of an adult or child is not demonstrated. It is the superior ventricle that shadows. Fluid is below, air above. The latter skiagraphs, the former does not. Hence the need of a double lateral skiagraph and both an anteroposterior and a posteroanterior plate, using a Dixon's 13° pillow.

Lesions in the cerebellopontine fossa occlude the 4th and frequently the 3rd ventricle, particularly if the growth is of an acoustic-nerve or brain-stem origin.

Lesions of the island of Reil have a tendency to occlude the body of the lateral ventricles. Each of these pathological central nervous system changes has an accompanying feature, interpretable from other special men's line of work. Lesions of the brain stem and cerebellopontine fossa have equilibration involvement, manifesting itself in nystagmus, vertigo and past-pointing changes. Growths in the internal capsule or corpora radiata areas have eye, labyrinthine and pyramidal tract symptoms. Each area of the brain, silent or known, in a sensory, motor or mental sense, has some individual accompanying feature. Ventriculography will demonstrate many brain-stem, cerebellum, and cerebellopontine fossa lesions, but interpretations of such from a distinct *x*-ray angle should not be undertaken. A correlative study of every angle of investigation of the case should be made; and then, and not until then, should the radiological expert hazard an opinion. Without correlative study such an opinion is but a presumptuous hazard, unscientific and uncalled-for.

Spinal intra-arachnoid air injections demonstrate the location of extra and subdural lesions quite accurately by the subjective symptoms of pain as well as the radiological demonstration of difference in density in the intra-arachnoid space. Intramedullary cord tumors hardly lend themselves to air interpretations. Obliterations of cerebellar sulci by cortical lesions are readily interpretable to one who has a working idea of the normal. Failure to demonstrate a certain section of the cortex when air has been used for interpretation is decidedly indicative of a lesion at that point. To induce the best in this new radiological method a series of normals should be collected and published. Without the use of air within the ventricles or intra-arachnoid space of brain and cord, the radiologist cannot aid further than summarized in the opening page of this paper, in diagnosing the central nervous system lesions.

Aneurisms of the internal carotid, psammomatous changes in pineal, pituitary or Pacchionian structures, brain-stem growths, calcareous changes in gliomatous cysts, arteriosclerotic changes in cortex and fissure areas, calcareous deposits, single and multiple, and even a complete calcareous degeneration of the entire brain, have been reported in medical literature in the last five years and have been interpreted by means of *x*-rays.

There is a great opportunity in undifferentiated stupor cases for roentgenological effort. The separation of the traumatic from the toxic or nephritic type of case can be markedly aided by anteroposterior, posteroanterior and laterally made skiagraphs of the skull. Each is a wet brain. Each is a stupor state due to compression of base and cortex. Tapping of the spine is therapeutic in the two latter and diagnostic by the finding of blood in the spinal fluid in the former.

Careful *x*-ray technique will frequently demonstrate extra- and subdural bloodclots. The presence of such differentiates compression from concussion. Spinal-fluid findings of blood confirm the suspicious shadows. On account of its many morbid characteristics the traumatic type demands early diagnosis. It is true that an early narrowing of the pupil, a later wide dilatation of same, or a trigeminal or seventh-nerve objective paretic symptom upon the side of injury, is frequently observed. These should serve as interpretable points; but often they are absent or have conflicting developments that preclude their serving in differential diagnosis.

The basilar fracture case, as Cushing and Sharp have amply proven, should be drained. The temporal decompression technique of Cushing has been utilized by Sharp, as well as by its originator, in hundreds of cases. A rubber-dam drainage of the incised temporal dura, with simultaneous removal of the clot, if easily accessible, and silverclip occlusion of vessel, if it is readily to be located, is the logical recognized technique today. Surgical intervention should follow an early diagnosis. Delay means increased surgical risk and the development of undesirable morbidity results.

Since the publication, years ago, by Little, the English orthopedist, of his observations of spastic paraplegia in children (now denominated Little's syndrome), it has been recognized that such was but the sequence of intracranial hemorrhage occurring at birth. Until recently too little attention has been paid to the immediate symptoms of the newborn, the later effects of which are now so well known.

The newborn that shows any of the following, either as single or group symptoms, should have a skiagraph made of its skull in the classical anteroposterior lateral method: poor suckling; irregular breathing; a slit-like, contracted pupil, later dilated; ecchymotic spots about the temples or eyelids; or dilated veins of the scalp. Children prematurely born, forcibly expelled by a multipara, are liable to a distortion of their delicate skulls with the result of rupturing the vessels of the dura, tearing of the tentorium-cerebelli, or developing petechial hemorrhages in the various nuclei neighboring the ventricles or the brain-stem. Children born of primipara approaching the end of their child-bearing period, instrumentally delivered or torsion-handled, are, of course, peculiarly liable to such intracranial trauma. There is another type manifesting two or more of the above-listed symptoms. These have had a perfectly normal birth, but despite this give evidence or suggestion of intracranial pathology. Such is the child with a navel or intestinal hemorrhage symptom. This type has a slow coagulating blood-finding and a prolonged bleeding period. The need of early diagnosis in these varied types of afflicted newborn is apparent. If they survive the first few days and are improperly treated, they are apt to develop into simple-minded, hemianopic, spastic or epileptic children. The radiologist can aid in an early diagnosis.

Fissured fracture is the type occurring in the newborn patient in a trauma of the bone. Fissured fractures follow in a radiating way from the centers of ossification. The parietal eminence is a frequent base of such fissured fractures. Intra- and extra-dural clots should be demonstrated by a soft technique. The treatment of this pathology of the newborn is location of the clot by radiology, followed by surgical handling of the case. Cushing calls the newborn a spinal type of animal. Literature reports show that the risk is light in comparison to the results in the untreated case. If the child can be saved from the subsequent well-known morbid developments, surgical chances should be taken. This is a field well worthy your skill and needs the utmost finesse in methods to differentiate the type, preceding surgical efforts.

The spinal types of pathology differentiated for the neurologist by radiology can be briefly listed under the head of the varied forms of spinal spondylitis and new growths, each developing bone changes. Syphilis, whether in the newborn (the congenital type) or in the adult (acquired tertiary type), leaves its stamp upon cortex of bone and mainly upon the shaft of the long bones. Charcot's joint is the one outstanding exception to this pathological rule. The toxic irritation of the periosteum in this disease leaves the tooth-edged shadow of Pacini, or the chalk line of increased compact structure of Post, radiologically observable in the adult. Bela Alexander, noting the epiphyseal absorption points, and the independent similar findings noted by Shipley, Pearson, Weech and Greene, in the newborn, lends to this type of neurological pathology a bone interpretation that differentiates syphilis from other types of spondylitic lesions.

Infectious arthritis is also an osteoclastic cell stimulant. Carcinoma and tuberculous and sarcomatous lesions are osteoporotic developers. Bone destruction is radiologically demonstrable, when either of these pathological states is the etiological explanation of a compression myelitis. Typhoid spondylitis may or may not be bone-destructive. It is a question of the period of the vertebral presence of the disease. Early skiagraphs of typhoid bone lesions demonstrate bone overgrowths; late skiagraphs, a bone-destructive process. Correlative study of case history and physical findings should be used in differentiating the varied forms of spondylitis. Carcinoma is practically always metastatic. Sarcoma is nearly always a primary lesion. Tubercular spines may be primary, but nearly always have a concomitant pulmonary lesion or are accompanied by an involvement of some other joint. Syphilis has a story of infection and serological proofs of its presence. Typhoid has a history of a recent attack of protracted intestinal trouble.

With spine neurological differentiations in mind, the radiologist should always insist upon a case history. Many central nervous system troubles have distant points of manifestation. Morvan's type of syringomyelia, with its changes in the first phalanx of the digits, the cupula-domed diaphragm, manifestation of phrenic nerve injury or involvement in cord lesions, is one of these. The clinician and the radiologist must be constant consultants. Insistent painful backs in the lower dorsal or upper lumbar region, varying in degree, frequently spell Kuemmel's disease, an unrecognized compression fracture of the body of the vertebræ with an over-bone growth about the transverse process. Sacralized fifth lumbar vertebræ, radiologically located, frequently explain the protracted type of sciatica.

There is, then, for the radiologist a wonderful field in neurological diagnosis. Shadow summation in skull skiagraphy needs an intimate knowledge of the base formation and the suture lines of the skull for proper interpretation. To us who are interested in central nervous system lesions, you are very essential consultants. Your efforts and the labors of the serologists, the neuro-otologists and the ophthalmologists must correlate with the clinical story and our physico-neuro findings, to make the diagnosis of central nervous system lesions approach accuracy.

In conclusion I have but these perhaps presumptuous suggestions to make: Remember that you are consultants, and important ones, too. Remember that the clinical history of the case is as essential to you, if you wish to be accurate in all branches of your labors, as it is in neurological interpretation. Demand of your confreres the fullest of cooperation in communicating to you the complete findings of others before you render an opinion in an interpretative sense. This is due you; moreover, the patient is entitled to cooperative conclusions. Others are hazardous to them as well as to you.

Ventriculography as well as intra-arachnoid injections of air will remain, I hope, the labor of the neurological surgeon or become a new field of roentgenological effort only after a safe technique has been acquired by the latter medical man. Trephining the skull under a local anesthesia, using a small Doyen burr, is not difficult, it is true; tapping the lumbar arachnoid space does not demand an excess of surgical skill; yet each needs an anatomical knowledge and an aseptic technique which, in my opinion, makes it, for the present, the province of the neurological surgeon, and not the radiologist.

The demonstration of the unoccluded lateral ventricle as well as the filling of the third and fourth ventricle with air needs another special line of study. The recognition of the normal as to contour, size and relationship of these structures makes of this new indirect roentgenological agent a very interesting bit of study. The use of air in cortical and ventricular shadowgraphy is but another indication that soon your specialty will be further divided into therapy and skiagraphic divisions. There will be a new and separate branch entitled, in all probability, "Interpretology." The latter will be based upon a special course which medical schools should now have and be prepared to give to the man making a specialty of roentgenological work. It would seem logical that roentgenology should be subdivided in its teaching courses into roentgenological pathology, roentgenological histology and roentgenological physiological branches, besides the ones at present pursued. Thus will be developed diagnostic roentgenological experts. This is not a criticism; it is merely a suggestion.

Radiological central nervous system interpretation, in my opinion, should be builded upon a correlatively examined clinical story and the use of other diagnostic aids. Roentgenological reports, unfortunately, are only too frequently rendered without a proper study of the history of the case. There is a definite and distinct *x*-ray pathology which is markedly separable from macroscopic and microscopic tissue changes. The surgeon, wishing to be right, rarely voices a macroscopical interpretation without a knowledge of the clinical story of the case; the microscopist frequently errs who attempts a lens interpretation summary without considering the patient's history; and yet your average medical colleague anticipates from you a positive diagnosis without the aid of a collated history or an understanding of the other man's findings. This is unfair to you and unjust to the patient. Demand of your confreres an accompanying clinical story of the case which he requests you to diagnose radiologically. Roentgenology has a high diagnostic place to maintain. You are consultants in the fullest sense of the word. Other consultants of special types demand a pitiless publicity concerning every feature of the case before even starting their investigation. Do likewise.

DISCUSSION

Dr. Stewart. I wish to mention the routine examination of unconscious patients brought into the hospital. We have found that our statistics with reference to the presence of fracture have greatly increased since we routinely sent them to the *x*-ray department for examination. It is very important to examine the entire skull. You may otherwise overlook something that would be very valuable to the surgeon.

Dr. Schultz and his associates have quite persistently found that *x*-ray findings are of value as indicative of injury to the brain substance on the opposite side. They claim that the strength of the blow is sufficient to force fluid around and injure the brain substance at that point. One of the great difficulties in ventrilography is the sustaining of the needle through the opening of the skull while the air is injected; and Dr. King of New York has devised a very ingenious thing: a screw which screws into the opening of the skull. On that his needle rests on ball-bearing arrangements, so that it is always supported.

Dr. Crouse (closing discussion). In conclusion I want to say that the selection of your needle for tapping the brain is very essential. It is a great deal of trouble to maintain the needle in the ventricle. I am glad to hear of Dr. King's technique. We are anticipating great things from the radiologist and we sincerely trust that in another year you will say "By this method and by that method, and by this technique and that technique we can safely aid you in 85 per cent of the cases." We think it is coming and we are looking to you to do it.

TRANSLATIONS AND ABSTRACTS

Stevens, Rollin H. Advances in radiation therapy of deep-seated tumors. *J. Mich. M. Soc.*, Mar., 1923, xxi, 124.

This is a review of our knowledge of physics covering the principles of deep therapy. The author reviews in detail the work which has been done by the various German clinics and refers to some of the theories of the biological effect of *x*-rays. A part of the article is devoted to an interesting discussion of the question of surgery in cancer. The author doubts the expediency of radical operation in most cancers for the following reasons:

1. The removal of all the reproductive elements of cancer by the most radical surgical operation is probably impossible, in the great majority of cases. The history of the surgical treatment of cancer substantiates this statement.

2. There is much evidence that the connective tissues about a cancer are important factors in the cure of the disease, and their help can be greatly increased by stimulation with radiation. These tissues, therefore, should not be removed surgically, or destroyed by any other means.

3. Radiation does destroy cancer cells, directly or indirectly. Whether directly or not, it probably stimulates the connective tissues about the growth so that they proliferate, crowd out the cancer cells, and possibly secrete immunizing, biological substances against cancer.

4. Metastases are usually more sensitive to radiation than the primary growth. (Exceptions to this are cases of metastases in the neck.) Therefore, if surgery is required the author believes it should be limited to the primary growth; and the sterilization, so to speak, of the cancer field should be left for radiation to accomplish.

Pre-irradiation is better if given four to five weeks before surgery. Thus is the field made safer for operation.

ANNULAR SHADOWS: ARE THEY CAVITIES OR SPONTANEOUS PNEUMOTHORACES?*

BY PHILIP KING BROWN, M.D.

Medical Director of Arequipa Sanatorium; Consulting Physician to Southern Pacific and Mount Zion Hospitals
SAN FRANCISCO, CALIFORNIA

THE use of the term "annular shadow" has led to a great deal of confusion, and, until its significance is settled, promises to interfere seriously with proper therapy of lung cases which show these shadows. If they be pleural manifestations of localized spontaneous pneumothoraces, they are not of very great importance, but if they can be proven to be lung cavities, as the writer believes them to be, the lighter interpretation of their significance, placed upon them by Brown, Sampson and Heise[1] and a host of followers, is a grave matter. It will delay adequate therapy in many cases in which the shadows do not disappear as the surrounding lung condition improves, for no one will deny that cavities of considerable size do close and become healed by the contraction of fibrosis, and by their obliteration and subsequent metamorphosis as a result of artificial pneumothorax.

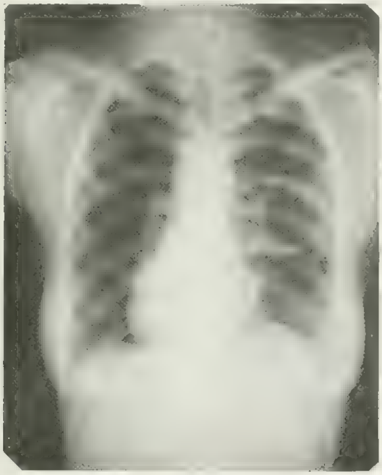


FIG. 1. Annular shadow showing opening into bronchus; posterioranterior position.

The differentiation of cavities from pneumothoraces was discussed in 1917 by Fishberg,[2] who used the term "annular shadows" in a generally descriptive way. Evans[3] followed with an address before this society, in 1918, in which he referred to Fishberg's[2] article and to the work of the Saranac School on annular shadows, which he had observed. He accepted their interpretation of localized pneumothorax without question or reservation. The Saranac group, Lawreson Brown, Sampson and Heise followed, the next year, with an article reviewing their own work and limiting the discussion to annular shadows seen in roentgenograms showing linear lung markings, but with no central rarefaction as compared with the outlying field. They regarded many of them as being in the interlobar fissure and associated them with the adjacent pulmonary process, owing their formation to the reaction of the pleura to perforation of the lung.

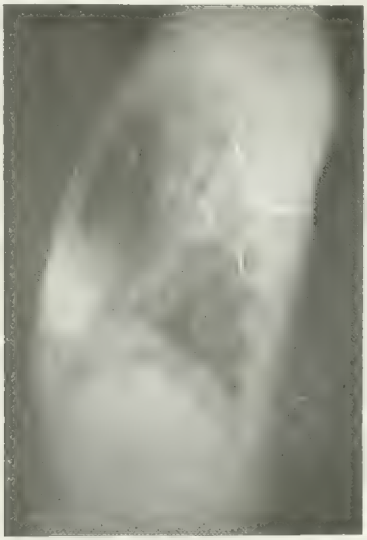


FIG. 2. Lateral plate of case shown in Figure 1.

Twelve per cent of a series of over 400 cases showed annular shadows with the roentgenographic features of density, and linear markings similar to those of the lung field surrounding the shadow, and in contrast to the other annular shadows with central rarefaction and without lung markings.

---

*Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922.

Following this article, Amberson[4] of the Loomis Sanatorium presented a review of 50 cases in which he found the type of annular shadow defined by the Saranac group, and in a series of 100 consecutive examinations he reported 20 per cent as showing these shadows. He likewise, accepted them as pneumothoraces, but introduced as explanation of their origin the idea of their being primary pleural lesions of unusual type. Recently he has published further studies of these shadows, which he describes, in one case, as following a resorbing pleural exudate and disappearing as the condition of the pleura returned more toward normal. One of these shadows was not round, but triangular. He presents the fact that clear fluid was withdrawn from such a shadow showing a fluid level, but gives no illustration or description of the lung condition.

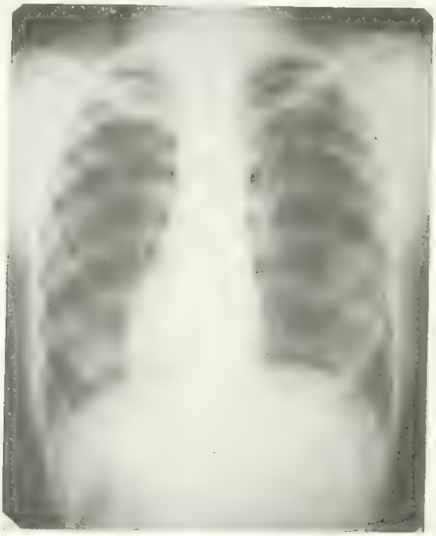


Fig. 3. Cavity outline.

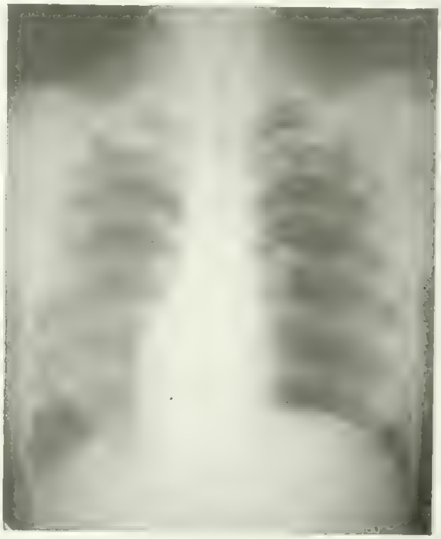


Fig. 4. Complete disappearance, six months later, of cavity outline seen in Figure 3.

The next contribution to the problem comes from Honeij,[5] who discusses "cavity formation and annular pleural shadows." He, too, accepts without question the localized pneumothorax interpretation, but injects a third idea of the pathology, which certainly adds to the confusion. He divides annular pleural shadows into true and false. True shadows, he states, are the result of adhesions following inflammation. "Under certain conditions"—what they are is not stated—"there is an oval or circular arrangement of the pleura to the formation of which the movement of lung and thorax contribute, resulting in the formation of central or local pseudo emphysema." The area around is the more firmly attached organized pleura.

The final contribution comes from Barlow and Thompson,[6] who, in a preliminary report on the subject, say that pneumothorax is the rule rather than the exception in lung tuberculosis, and assume that "annular shadow in the pleura is one of the easily recognized indicating signs of pneumothorax." Even if they mistake cavities for pneumothoraces, they are still wrong in claiming pneumothorax as the rule in lung tuberculosis, as the records of any good roentgenological laboratory connected with a public hospital or sanatorium for advanced cases will disclose. In our own 800 cases at Arequipa Sanatorium, largely early ones, the total number of distinct spontaneous pneumothoraces does not exceed 3 per cent of the patients, of whom for the past eleven years we have had roentgenological studies, often six to ten plates of many of the patients. Even Amberson does not get the percentage of the annular shadow cavities which he calls pneumothoraces over 20 per cent. Barlow and Thompson's further statement that "annular shadow in the pleura is one of the easily recognized indicating signs of pneumothorax" is also wrong, unless limited by the words "in good *x*-ray plates." In my experience with the oldest clinicians in the country, these so-called annular shadows are peculiarly likely to give no physical signs, and, unless of considerable size, or not draining freely, they are very commonly overlooked in physical examinations.

A brief critical review of the contentions of these supporters of the pneumothorax interpretation may clear the situation. No autopsy examinations of their own or of others support their contention, and the pathological explanation by Amberson and Honeij of the origin of these shadows is against known evidence, and seems made to fit a theory.

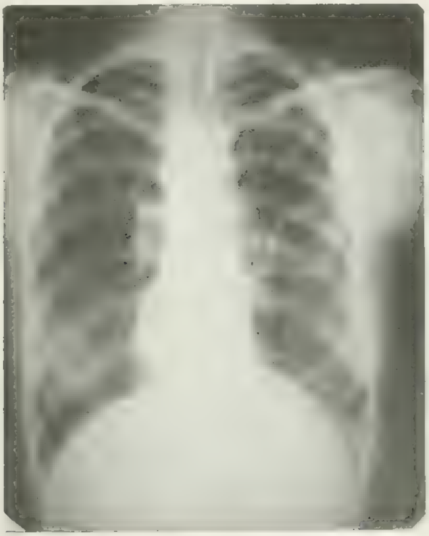


FIG. 5. Dec. 24, 1921. Annular outline between third and fourth ribs, anteriorly, showing opening into bronchus.

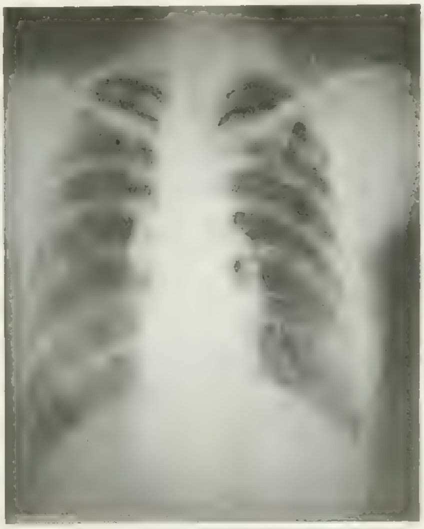


FIG. 6. Jan. 16, 1922. Same case as in Figure 5, after 600 c.c. of air.

Evans criticizes Dunham's[7] interpretation of some of his stereo-clinic pictures and sweeps the soundness of Dunham's studies aside without a single logical argument or substantiated deduction. To quote Evans, "Dunham failed to show that this question had been discussed, and, in fact, several cases described as showing cavity formation were in reality cases of localized air pockets." Evans continues: "In making a report on a chest examination last fall, we noted an annular shadow which we described as atypical of a cavity, but no suggestion was made that it might be a localized pneumothorax. There was a small amount of fluid present in the circumscribed area, this supporting the view that the condition was one of cavity formation. Plates made several weeks later of the same case showed a marked diminution in the size of the supposed cavity and showed the absence of fluid. This of necessity suggested that our first interpretation was an error."

Evans does not make clear why several of Dunham's cases were "in reality cases of localized air pockets." No man in this country has studied chest plates and autopsy findings of cases more faithfully than Dunham, and in a personal communication to Burnham he has said that he never saw an annular shadow which he diagnosed as cavity which was not a cavity at autopsy. Dr. Evans does not give his reason for calling the cavity in his examination quoted above "atypical." Certainly the small amount of fluid present could not be atypical of cavity, nor could its absence a few weeks later. If this be admitted, then Evans was swung over to a new interpretation of his findings by the sole fact that the shadow showed a "marked diminution in size," which he considers common in localized pneumothorax and uncommon in cavity. To this we cannot agree.

The real responsibility of advancing the pneumothorax idea as an interpretation of annular shadows rests with Brown, Heise and Sampson of the Saranac School. As that institution holds the leading place in the country for the teaching of clinical aspects of tuberculosis, a grave responsibility rests upon them if it be proven that their contention is wrong and that their so-called annular shadows for practical purposes are never pneumothoraces, but are cavities. The proof that they are cavities the writer of this paper hopes to make so strong and convincing that it will put the matter forever at rest, and serve to undo some of the harm that has been done by their paper, as has been shown by its too ready acceptance.

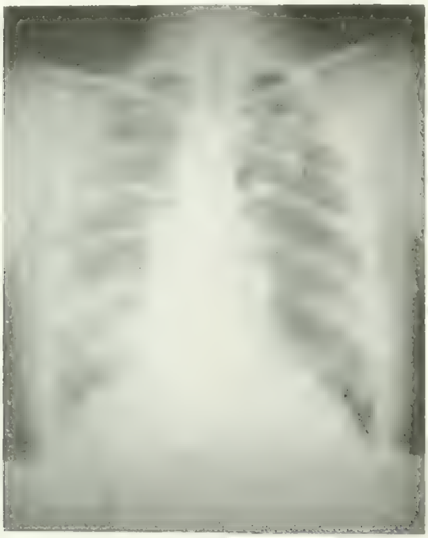


Fig. 7. Jan. 24, 1922. Same case, after two more air introductions totaling 1,200 c.c.

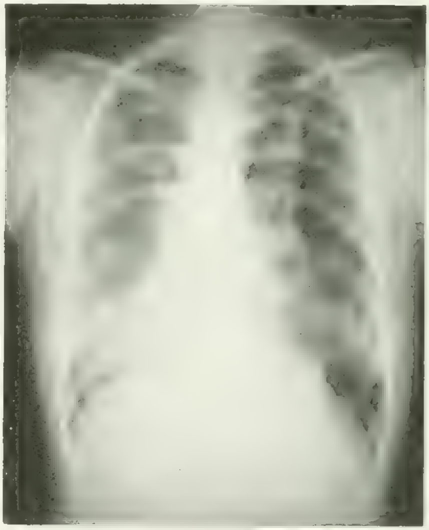


Fig. 8. Feb. 16, 1922, after further collapse.

The fact that many of the sanatoria in the east belittled the value of *x*-ray for years has prevented, possibly, their collecting large series of plates in which the pathological conditions of the lung showed graphically the changes which they had been accustomed to describe clinically. Had serial plates been the rule in studying cases, the clinicians would not have fallen into the error of belittling the value of their own examinations and depended so entirely on a roentgenologist's interpretation of a clinical condition. This point is illustrated by Figures 1 and 2, showing annular shadows which were diagnosed as cavities in 1912, and what has happened to them in the ten years that intervened. Figures 3 and 4 show the enormous distortion of the thoracic contents in another one-sided case, where the right lung was once honeycombed with cavities. In both of these cases, adhesions prevented successful closing of the cavities by artificial pneumothorax, although the partial collapse and subsequent diffuse adhesive pleuritis probably assisted in the retraction of the diseased lung and the partial closure of the cavities. It has been our experience that cavities as large in diameter as 3 or 4 and even 5 cm. can close in a relatively few months if conditions are favorable. The fact must have presented itself to everyone who has studied the expansion after pneumothorax, that the diseased part of the lung expands more slowly than the unaffected part. In other words, without the disease there is less tendency to the formation of fibroid tissue, and it is by fibrosis that contraction of the cavities takes place. Adhesive pleuritis helps by pulling over the heart and mediastinum and raising the diaphragm. The adhesions seem to take in the slack from the lessened movement of the affected side.

Against Honeij's views much can be said. He is vague on the proposition of just what he accepts as annular shadows, and too much of his explanation of size, type, location, wall thickness, shape, size in relation to healing, etc. of cavities, we cannot agree with. It is hard also to fathom the idea advanced regarding the relation of "true annular shadows" and the breaking down of lung tissue. He says: "It is true that the two conditions may co-exist, but equally true that pleural changes may be secondary to cavitation, or vice versa. *Consequently*, if a case is presented in which cavitation is accompanied by a pleural annular shadow, it is generally impossible to differentiate the two conditions." If Honeij means what he says, he admits that a cavity may assume all the characteristics that he ascribes to localized pneumothorax. That is exactly the writer's contention, and Honeij's statement reminds him of the story of the little boy who answered the question as to authorship of the Odessy by saying that it was not written by Homer but by another man of the same name. There is a further vein of humor in his final admission that "one must determine whether the disease is sufficiently advanced to make diagnosis of cavity probable. . . . If physical signs are insufficient to establish the diagnosis of cavity, the assumption is warranted that the annular shadow is due to pleural inflammation." And yet he quotes Norris, Ribadeau-Dumas and others as to silent cavities and the unreliability of signs in general.

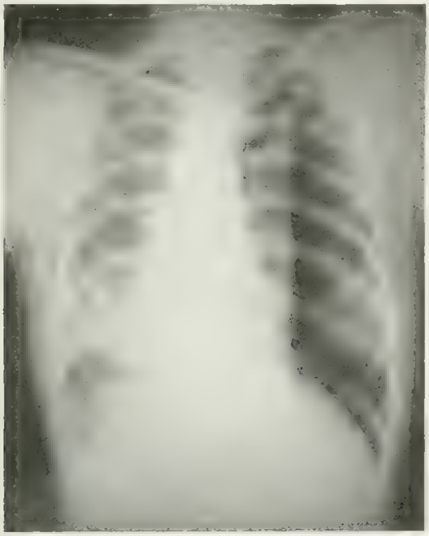


Fig. 9. Feb. 23, 1922. Complete collapse prevented by apex adhesions. Cavity outline markedly reduced in size and showing fluid level.

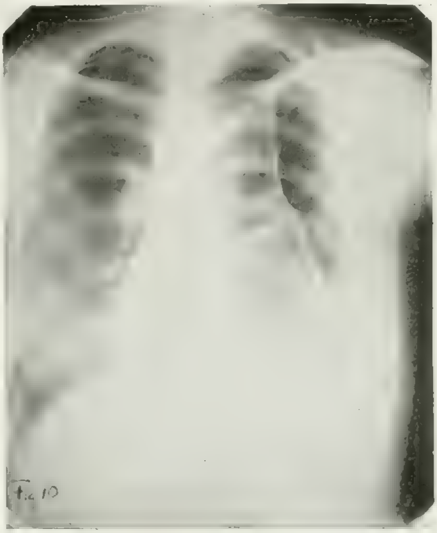


Fig. 10. Same case six months later. Cavity site marked by dense scar.

It would be unfair to medicine to close this argument without making quite clear that this controversy concerns lesions in the lung giving either no physical signs or very uncertain ones, in the vast majority of cases. Pathognomonic signs of cavity apply to large cavities superficially placed, or containing fluid through which entering air must pass, or in which the air is at times under conditions of tension giving characteristic sounds. The great frequency of cavitation and the method of its development by coalescence of honeycombed areas resulting from softening can be followed easily by serial *x*-ray stereoscopic plates. Screening gives no definition, but admits of study of an expansile and contractile movement of a cavity wall with cough, and flat plates are very often misleading. Even physical signs have to be weighed with the greatest care. In our experience, the increase or appearance of rales after cough following expiration is one of the most dependable signs, when weighed with impaired resonance, but it may be so simulated by pleural sounds as to make differential diagnosis dependent on the best of *x*-ray plates.

In spite of the frequency of cavitation without pathognomonic signs, and in spite of the inability to depend on our most classical signs, and in spite of the great contribution of the *x*-ray plate, physical examination is and will undoubtedly remain in the hands of well-trained physicians, the best means of determining degree of activity and of interpreting progress. That skilled physicians are the ones who should appreciate most of all the graphic methods of radiology as an adjunct to interpretation, their own writings testify.

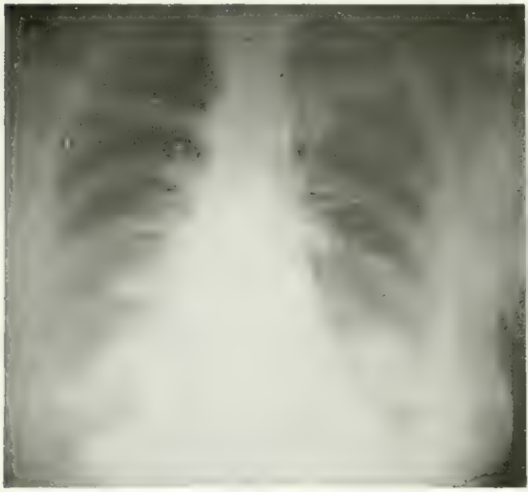


Fig. 11. Two "annular shadows" at right apex. Plate taken in 1913. Upper cavity under the clavicle, lower one from the center of the hilus out toward the upper axilla.

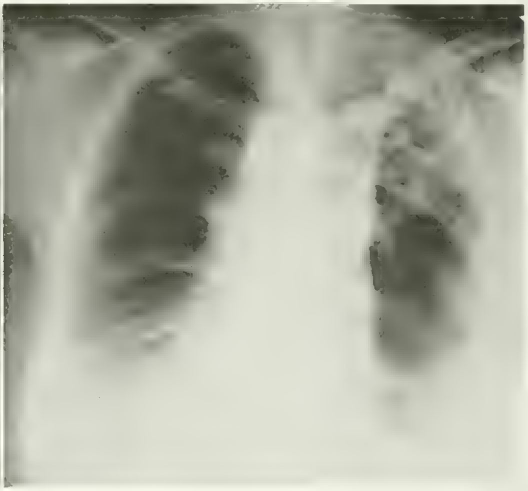


Fig. 12. Same patient, Oct., 1922, nine years later showing deviated trachea, high diaphragm, heart and mediastinum distortion. Cavities still present in markedly contracted right upper lobe.

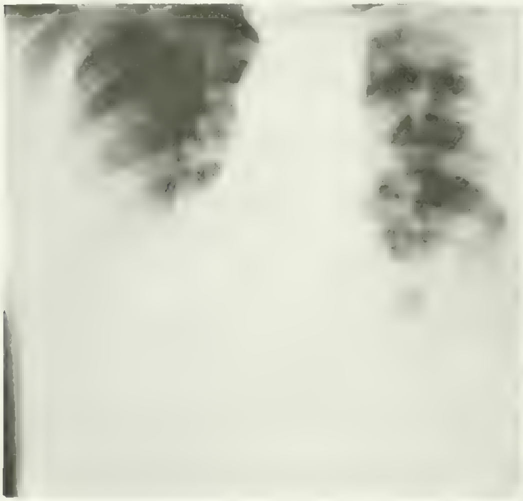


Fig. 13. Multiple cavitation in right upper lobe. Pleurisy at both bases. Plate made in 1917.

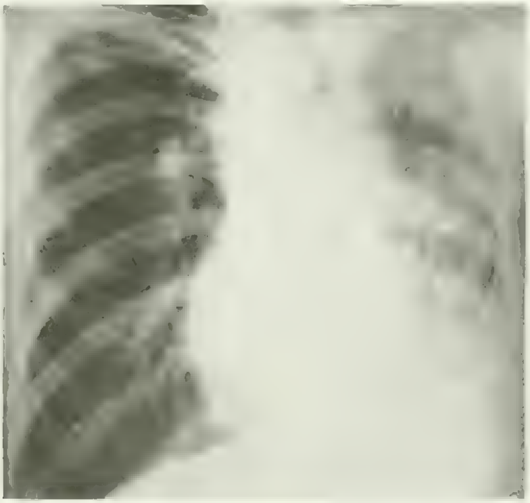


Fig. 14. Same patient two years later showing contraction on the right side. A clearing up of the pleural condition in the left lower lobe.

The reasons for believing that the interpretation of certain, or any, annular shadows as localized pneumothoraces is wrong are these:

1. In a critical examination of many hundreds of such cases, no such shadow, when subjected to one or more of the following tests, has been proven to be anything but a cavity. While not denying

that a localized pneumothorax *may* show as an annular ring form, the writer has never met such a spontaneous pneumothorax, although he has seen a good many recent ones in *x*-ray plates, none of which pneumothoraces was to be confused with cavities, and none was round. Furthermore, stereo plates of artificial pneumothorax where adhesions have limited the air to 100 c.c. or less, have never assumed the appearance of these annular shadows (Fig. 1).

2. Anteroposterior and lateral views of these conditions show them to be equally round in both directions, which could be true only if they were cavities (Figs. 5 and 6, etc.). Apex cavities cannot be shown this way, owing to intervening structures.

3. Artificial pneumothorax will first compress and then collapse these shadows and move them from their original positions, which would be impossible if they were in the parietal pleura (Figs. 7, 8, 9, 10 and 11).

4. If unilateral, and found sometimes to contain fluid, the shadow may be studied by *x*-ray in the morning after the patient has spent the night on the affected side, *before* the cavity has emptied itself and *after* postural effort at emptying. Pneumothoraces containing fluid will not empty. Matson has injected methylene blue into such an area and had it expectorated at once.

5. Finally, stereograms such as we have been fortunate enough to get, taken in $^{1}/_{60}$ second each, so that there is no interference with outlines due to motion transmitted by heart action, give a detail never secured before in lung plates, and show not only the perspective of these shadows, and that they are cavities, but orient them in their relation to the chest wall, show their connection with bronchi, and how they increase in size by coalescing with adjacent and often very small cavities or by including softened areas which border on them.

If any or all of these tests are applied to "certain appearances in *x*-ray plates of the chest" not recognizable by clinical signs, we contend that they will be found to be cavities, and that for prognostic and therapeutic purposes they must be so regarded even when satisfactory means of proof are not available. At least, let us apply the test and not give so grave a condition as a cavity an interpretation that might end disastrously to the patient. Consider all annular shadows as cavities until diligent investigation proves that they are to be better interpreted some other way.

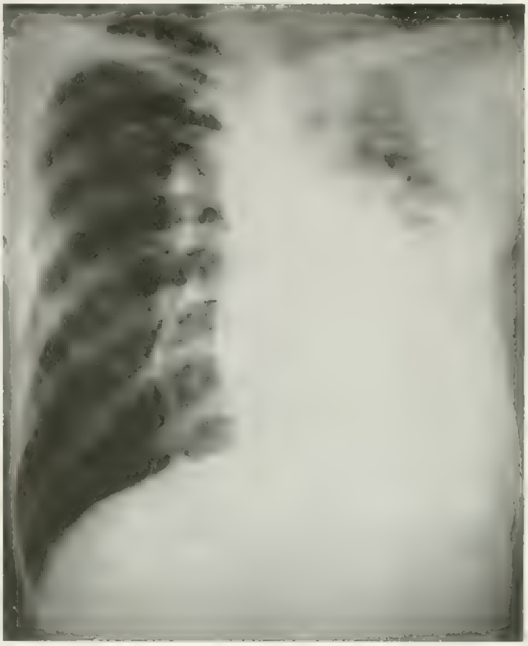


Fig. 15. Same patient three years later still showing the heart far over on the right side; marked curve to the right of the trachea. Right diaphragm pulled up very high. Interspaces markedly narrow. Cavities at right apex still unclosed.

BIBLIOGRAPHY

1. Sampson, Heise and Brown. *Am. Rev. Tuberc.*, 1919, ii, 664.
2. Fishberg, Morris. *Arch. Int. Med.*, Nov., 1917.
3. Evans, W. A. Am. J. Roentgenol., Oct., 1919, vi, 510.
4. Amberson, J. B. *Ibid.*, 1921, v, 723; *Ibid.*, 1922, vi, 481.
5. Honeij, J. A. *Arch. Int. Med.*, Jan., 1920 p. 65. *Am. Rev. Tuberc.*, Aug., 1922, p. 477.
6. Barlow, N. and Thompson, J. C. *Am. Rev. Tuberc.*, 1921, v, 611.
7. Dunham, K. *Trans. National Tuberculosis Assn.*, 1919, p. 324.

DISCUSSION

Dr. Burnham. I accept what Dr. Brown said regarding the fact that annular pneumothorax does not exist. We are all familiar with localized pneumothorax. It is never annular in contour.

Four cases of so-called annular pneumothorax have been autopsied, and they proved to be cavities.

Annular shadows, the center of which have the same density as the surrounding lung, with linear lung markings, are a sign complex not difficult to keep in mind; but if we wander away from the subject to talk about localized pneumothoraces not of this type, it complicates things.

The question of the walls of the cavities has received very little consideration from any one. During the past year Dr. Brown and myself have tried to find out about the formation of the cavity walls as regards thickness. Why do we see thin and thick ones? In our work we were struck right away by the fact that in these thin-walled cavities there was, at the bottom of each, a large opening into the bronchus. We thought that was a factor in the formation of thin walls: viz., easy drainage, with a large opening in the dependent part of the cavity. That is presented for what it is worth. Many other factors must enter into the formation of the wall.

I would like to ask the president if he would call on Dr. Matson to discuss the paper.

Dr. Evans. It is evident to me that I am on the defensive. Some five years ago I made my first observations on this subject. A year later I studied the work with Dr. Thompson, and the same fall I published my observations.

In spite of the fine paper this afternoon, I am still unconvinced that there are not annular shadows which are not cavities, for these reasons: First, I have been able to tell in advance when a shadow would appear, and have studied serial plates in which I have first noted a superficial lesion and secondarily noted an annular shadow which was round, and which represented in general appearance the shadow shown this afternoon. I believe all these shadows which I have seen were cavities, with possibly one exception. In spite of that, there are, in my opinion, annular shadows which are not cavities. In the second place, we have considered the associated pathology. I have seen annular shadows in cases of so-called apical tuberculosis in which you would not find cavity formation because it is acute. I have seen the same lesion in so-called peribronchial tuberculosis. In that type you would not expect to find cavity formation. On the other hand, we have studied cases serially, and have observed that those annular shadows do change rapidly in size and outline.

I am classifying now 2,000 chest cases and I hope to get positive figures. Burnham referred to the post-mortem finding in a case in which there was found an annular shadow which he said was localized pneumothorax. That is reported in the *Journal of Tuberculosis*. As a further proof that some of the shadows are not cavities, I believe that some workers have been able to withdraw a serous fluid from an annular shadow. Some cavities have been injected and the patient has been able to cough up the solution placed in the cavity.

I think the matter is important and that we appreciate the discussion. Since my formal report, I am frequently called upon to say that I cannot properly classify annular shadows: they may be cavities or localized pneumothoraces, and the subject requires further study.

Dr. Matson. The question of annular shadows and cavities is one which has concerned me a great deal during the past few few years, especially after reviewing the literature. The frequency of spontaneous localized pneumothorax is much more frequent, according to the men describing this condition, than we have found in our own experience.

The question of differentiation between closed pneumothorax and cavity is very easy because it requires only the introduction of a needle. If one introduces atmospheric air in this cavity, it will escape through the bronchus. If we inject weak dilution of methylin blue, it is expectorated. But the question of differentiation between localized closed pneumothorax and circular lesion is much more difficult. We have seen in roentgenograms many times what we thought to be a circular lesion and would prove it to be a cavity although there were no physical diagnostic evidences of cavity. We all know that cavities exist in the lung.

We know that in most instances in a cavity, if close to the chest wall, there is always a patch of adherent pleura over the side of the cavity, and we have watched the separation of these bands.

Dr. Manges. This is a very interesting situation. The original work of Sampson, Heise and Brown seems to have been very well done, at least from the roentgenographic point of view. And now Dr. Brown and Dr. Burnham, men of renown and ability, take the stand that the interlobar annular shadows do not exist. I think we ought to look upon the pros and cons with at least a fair thought to both sides. I am convinced that they are not of frequent occurrence, but I feel equally certain that they do exist, and that they may or may not contain air; or, in other words, that they may not even be pneumothoraces.

There are questions that may be asked of either side. First, if it is an interlobar pneumothorax from a perforating tuberculous focus, why does not a complete pneumothorax develop? Spontaneous pneumothorax is supposed to occur in this way and should produce sudden symptoms. On the other hand, if these large cavities are always the result of abscess in the lung tissue, why do we not always get a history of acute illness with sudden expectoration of a quantity of pus, or roentgenographic evidence of the formative stage of the abscess? And why is it that in many of the cases there is very little other roentgenographic evidence of tissue change in the lungs?

Again, granting that encapsulated pneumothorax is a pathologic entity, what is there to prevent the formation of exudate, or of its communication by way of ulceration with a bronchus? Why should not such a cavity have depth in all diameters, or be more or less spherical? And why should it not respond to treatment by compression, the same as any other cavity?

Thinness of the limiting wall offers further opportunity for argument. I am sure I have seen such shadows that were incomplete, or with part of the wall so thin as not to be recognizable in shadow. I have one case in mind in which there were numbers of these annular shadows. Some of them, I believe, represented cavities in the lung tissue; others were not truly annular, had little if any depth, and, on the left side especially, were distributed from above and behind, downward and forward in the line of the interlobar fissure. (Stereoscopic slides of this case were sent to Dr. Heise and he called my attention to distribution mentioned above.)

I have seen at autopsy, and especially during the flu epidemic of 1918, instances of localized pleuritis between the lobes, the lesions being small or large, but often circular in outline, with well-organized adhesions at the circumference and more or less plastic exudate within the ring. It is entirely reasonable to suppose that, later on, such lesions would produce annular shadows on the roentgenogram.

I do not believe that the annular shadow of interlobar origin is very frequently seen, but I do believe in its existence. Further, I believe that many of the cavities with thin walls in the lower two-thirds of the chest, in the absence of advanced pathology in the upper third, are bronchiectatic, and not true abscess cavities.

Dr. Bowen. This subject is exceedingly interesting to me because of working with Norris for two years. In formulating a rather set type of instructions in roentgenology for classes, he just recently came to the conclusion that we should leave out any reference to annular shadows, for the reason that we then considered the data a controversial subject. Norris has had an exceedingly large experience in watching pathological post-mortem examinations, and is sure he has never seen one.

On the other hand, there is a case that had even more of these than the one which Dr. Brown called to our attention, and while his impression seems to bear out the fact that these could hardly have been pneumothoraces, this man could not interest the tuberculosis dispensary in his case, even after we had shown the shadows. He seemed to have absolutely no physical signs, and I think there were seventeen of these shadows that we outlined very completely.

Dr. Brown (closing discussion). I should not like to be quoted as saying there is no such thing as an annular formed pleural shadow due to pneumothorax.

I had a case recently of spontaneous pneumothorax with symptoms of localized pleural irritation only, and had the roentgenologist point it out to me, because I had not found it on physical examination. It was not like anything that these people have called localized spontaneous pneumothorax of the annular shadow type, yet you all would recognize it as a nice limited pneumothorax in the plate. In the first place, you can see that the edge is not round, although it will probably get round in time from the effects of pressure. When small pneumothoraces first appear, they are never round, whether produced by lung rupture, or artificially, by air introduction. I see a great many of them in plates taken after the first artificial pneumothorax, where adhesions limit the diffusion of air, and I have never seen one that looks like a cavity. It is the old spontaneous pneumothorax that has the big thick wall and is relatively round, that is sometimes hard to tell from a cavity.

In regard to the question of cavities getting larger or smaller; if you will follow a case with small cavities, with plates made monthly, you will often see a change in the size of the cavity. Often you can see that it is getting smaller, and finally it disappears completely as a cavity. In unfavorable cases, it may get a thicker and thicker wall and grow slowly and symmetrically larger, or it may increase in size by incorporating other adjacent cavities or softened areas.

A great many people with bad cavities work up to the day they are put to bed never to get up. The undermining of vitality may be a gradual thing, and people do not recognize the seriousness of the situation until they are told what is wrong with them. In these progressive cases, annular shadows, properly studied, reveal promptly their true character.

CASE OF BULLET IN HEART WITH RECOVERY*

BY F. C. SWEARINGEN, M.D.

POMONA, CALIFORNIA

MR. M., aged forty-five, had influenza in December, 1918. During his convalescence his wife died of influenza pneumonia. On Feb. 17, 1919, being despondent, he attempted to take his life, after which he asked the telephone operator to summon his family physician. He was found lying, face down, inside his front door. He was unconscious, deeply cyanosed, with respirations stertorous, no pulse perceptible at wrist, and no heart tones to be heard over the cardiac area. Examination showed a bullet wound in the fifth intercostal space one-half an inch to the left of the sternum.

Fig. 1. Case No. 7075. Lateral view showing shadow of bullet within heart shadow.

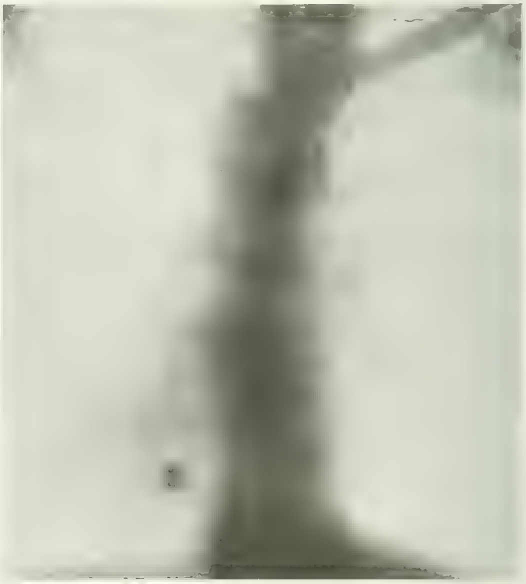


Fig. 2. Case No. 7075. Anteroposterior view showing shadow of bullet within heart shadow.

The patient was placed on his back and given $\frac{1}{60}$ gr. of strychnine sulphate hypodermatically. In a few minutes his respirations and color improved, and he soon began to regain consciousness. He was removed to the hospital where examination at 12.50 p.m. showed no radial pulse, very faint and indistinct heart sounds over the heart, and cardiac area of dulness very much increased. The patient was entirely conscious and complained of some pain in the left chest which was not aggravated by deep respirations. There was no nausea, no expectoration, and no cough at this time or at any time during his illness. The wound of entrance was dressed, and no wound of exit could be found.

At 1.35 radial pulse was perceptible for the first time, but not strong enough to make it possible to count pulse, nor were the heart sounds clear enough to count pulse with the stethoscope.

At 1.50 the patient became very restless and complained of severe pain in the chest.

At 3.00 the radial pulse was strong enough to count, regular in rhythm and registered 98 per minute.

The patient rested fairly well during the rest of the day and slept some during the night. The following morning he took a little liquid food.

During the next six days the pulse varied between 80 and 100, was always regular, and gradually increased in volume. The heart sounds also gradually improved in clearness. From the sixth to the twelfth day the pulse ranged between 70 and 90, the cardiac dulness decreased and the heart sounds became clear and distinct.

---

* Thesis presented leading to membership in The American Roentgen Ray Society, 1921.

Improvement was uneventful from this time, and the patient left the hospital on March 4, 1919.

Examination of the house immediately after the shooting showed that the patient was lying on the bed at the time of the accident, his revolver, a 32 caliber, and some small pieces of a vest-button which was shattered by the bullet being found on the bed. From the bed he walked 15 ft. to the telephone. Fresh blood-stains on the directory showed that he had attempted to find his doctor's telephone number. After calling central and asking her to summon his physician, he walked another 20 ft. to reach the front door, where he was found, and where he evidently collapsed.

On March 11, 1919, the patient walked into my office seeking a roentgen examination. He was at that time experiencing some difficulty in the muscular action of the 4th and 5th fingers of the left hand, and his physician thought perhaps the bullet had traversed upward and located in the region of the cervical plexus.

The wound of entrance was still plainly visible. The patient was placed in the anteroposterior position before the fluoroscope, and immediately a foreign body was noted just posterior to the wound of entrance and within the shadow of the heart approximately midway between the right and left borders and approximately 2 cm. below the greatest diameter of the heart. There was an oblique movement of the foreign body with each impulse of the heart.

The patient was then rotated in both directions with the shadow of the foreign body always in view. At no time did it pass out of the shadow of the heart.

In the lateral view, the shadow of the foreign body was situated approximately 1 cm. anterior to the mid-axis of the heart shadow.

Owing to the movement of the heart, roentgenograms were taken with the aid of the intensifying screen, plates being taken in both the anteroposterior and the lateral positions. Each of the plates thus exposed shows the shadow of the foreign body well within the shadow of the heart.

A second examination was made on Sept. 14, 1919, six months after the accident, with the same findings as the first, except that the heart shadow was perceptibly smaller. A recent examination reveals no change, and the man is at present working at moderate manual labor in a fruit packing house, apparently enjoying the best of health.

I am indebted to Dr. A. L. Weber of Cucumonga, Calif. for assistance in the history of this case.

THE LUMBAR TRANSVERSE PROCESSES

BY MORRIS I. BIERMAN, B.S., M.D.

U. S. Veterans' Hospital No. 35

ST. LOUIS, MISSOURI

IN following a routine for gastrointestinal examinations—wherein a preliminary radiogram of the patient was taken in anteroposterior direction—of the kidneys, gall-bladder and lumbar spine, there have frequently been observed solutions of continuity of the transverse processes of the lumbar vertebrae, usually unilateral, but at times bilateral. These were diagnosed as congenital anomalies, and the question of pathology was never brought up. These cases were never reported as showing pathology of the spine in the preliminary radiogram.

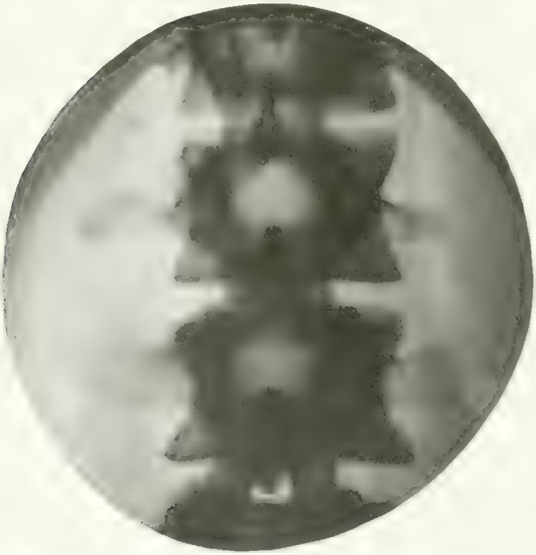


FIG. 1. Unilateral lumbar rib simulating fracture of the transverse process of the first lumbar.

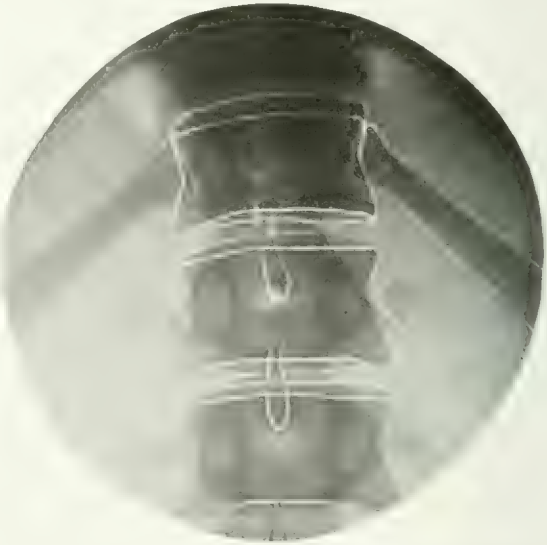


FIG. 2. Bilateral failure of the secondary epiphyses of the first lumbar to fuse. Before retouching of film the condition very closely simulated fracture.

On one occasion, a case reported as negative on the preliminary examination was reported back as having had a roentgen-ray diagnosis of fracture of the transverse process of the first lumbar vertebra about three years previously. On re-examination of the film, it was found that the transverse process was divided into an inner two-thirds and an outer one-third. The line of division was sharp, somewhat curved, with the concavity directed laterally. The margins of the bone were smooth and clearly outlined, and there was no calcium-salt absorption present. In view of the history of an injury to the back in this case, comparison of the radiogram with other cases showing similar divisions of the transverse processes was made. No differences could be discerned of sufficient importance to indicate that the solution of continuity of the transverse process of the first case was of different character from the divisions noted in the other cases which had no history of back injury and were found only on routine preliminary roentgenograms.

A review of the development of the vertebrae in the lumbar region shows that in an embryo of about 15 mm., chondrification is already taking place. Each vertebra is provided with a rib process, but there is no separation between the rib and the primitive vertebra until late in the cartilaginous stage. In the cervical, lumbar, and sacral regions, the processes remain attached to, and become parts of, the vertebrae, but in the thoracic region, they grow around the body wall to form the free ribs. The costovertebral articulations are produced by absorption in the matrix between the ribs and the vertebrae, the surrounding mesenchyme giving origin to the costovertebral ligaments.

The rib process and the growing transverse process are at first united by a continuous blastema. This is absorbed as anastomoses are established between the segmental arteries, but between the end of the process and the rib a joint cavity is formed and the surrounding mesenchyme gives rise to costotransverse ligaments. The neural process, which is situated immediately behind the costal process, gives rise to the articular and the transverse processes. Centers of ossification appear in the body of each vertebra, and following this, a center appears in each half of the vertebral arch. Ossification of the arches begins in the upper cervical region about the seventh or eighth week of fetal life, and gradually extends down the column. The centers of ossification first appear in the situations where the transverse processes afterward project, and spread backward toward the spinous processes.

At birth, the vertebra is in three pieces, the body and the two halves of the vertebral arch. During the first year, the bodies of the upper cervicals join the arches. In the lower lumbar region, union takes place about the sixth year. The ossification takes place very slowly, and bone replaces the cartilage fairly late in life. At about the age of puberty, secondary centers of ossification appear in each of the cartilages that cover the ends of the vertebra. Secondary centers also appear in the cartilage on the tips of the spinous and transverse processes, and in the lumbar vertebrae one appears also on the tip of each articular process. The secondary centers unite with the vertebrae at any time between the sixteenth and twenty-fifth years.

Occasionally, anomalous development takes place, the costal process of the lumbar vertebra developing to a somewhat greater degree than usual and becoming separated from the vertebra. It fails to fuse with the transverse process and remains entirely separate as a lumbar rib. Occasionally, also, the secondary epiphysis on the transverse process of the first lumbar vertebra fails to unite with the transverse process, and produces a condition which simulates a fracture.

At times, difficulty in diagnosis may arise as to the presence or absence of a fracture when there has been an injury to the back. A lumbar rib should give no difficulty in diagnosis, provided the transverse process on the opposite side is shorter than the transverse process and lumbar rib on the suspicious side. The other evidences of fracture of the bone will also be absent. Where the secondary epiphysis has failed to unite with the transverse process, and the history is that of an injury, the greatest difficulty will arise. Here it will be seen that the lateral fragment is smooth, well outlined, shows no decalcification and has none of the characteristics of a fracture. Re-examination of this transverse process a few months later will show absolutely no change in the condition. One case observed about a year later showed the condition to be exactly the same as during his first examination. The average age of the patients was about thirty years.

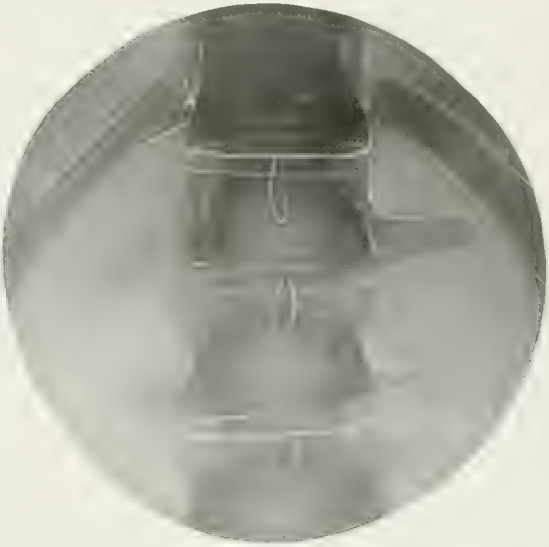


Fig. 3. Unilateral lumbar rib simulating fracture of the transverse process.

The anomalous development already described is not at all rare; in fact, it is quite common. It has been found to occur in about 5 to 10 per cent of all gastrointestinal patients examined over a period of about six months. The situation of the transverse process of the first lumbar vertebra is such that it is brought out on the radiogram with difficulty, and it is probable that faintness on the film is the chief cause of this condition being overlooked so frequently, unless there has been an injury to the back, and a special search is made for a fracture. It would be interesting to know how frequently this condition would be diagnosed as fracture. Radiograms of fractures of the transverse processes show a tendency to separation of the fragments, decalcification of the bone, irregularity of the adjacent margins of both bones, and other evidences of attempt at either absorption or union between the fragments.

CONCLUSIONS

1. The transverse processes of the lumbar vertebrae, especially the first lumbar, very frequently show anomalous development.

2. The unilateral lumbar rib is easily differentiated from fracture, unless the rudimentary rib is very short. Then differentiation must be made by the appearance of the bone, the situation of the lesion, and the lack of injury to neighboring parts.

3. Unilateral or bilateral failure of the secondary epiphysis to unite with the transverse process, while probably the least frequent of the two conditions, will, at times, also be difficult to differentiate if found after injury.

BOOK REVIEWS

Radium Therapy. By Frank Edward Simpson, A.B., M.D., Professor of Dermatology, Chicago Policlinic; Adjunct Clinical Professor of Dermatology, Northwestern University Medical School; Attending Dermatologist to Mercy Hospital, Alexian Brothers Hospital, Henrotin Hospital, etc.; Former President American Radium Society; Former Vice-Chairman, Section of Dermatology and Syphilology, American Medical Association; Director of the Frank Edward Simpson Radium Institute. Cloth. Pages 388, with 166 original engravings. St. Louis, 1922.

This most timely and welcome contribution to the literature of radium therapy is worthy of a place on the shelf not only of every radiologist but of every physician and surgeon. Radiotherapy has developed to the point where it should enter into the practice of every medical man, no matter what his specialty. Whether or not he actually applies the radium will depend on the circumstances and the effort which he has made to fit himself especially for the work; but the field of usefulness of this wonderful salt is ramifying into nearly all fields of medical activity to such a degree that it is incumbent upon every physician to familiarize himself with the general principles of radiotherapy, or at least to have upon his desk a book of reference, for ready use. This need is admirably met by the work under review.

The book consists of twenty-one chapters and an excellent bibliography. Every feature of radium work, both technical and clinical, is included, and the author has written his book in such style that it is a pleasure to read it. It easily takes first place in publications on radiotherapy up-to-date.

James T. Case.

TREATMENT OF CARCINOMA OF ESOPHAGUS BY DEEP X-RAY THERAPY*

BY A. H. PIRIE, M.D.

MONTREAL, CANADA

THIS paper is not a record of successes, but rather an inquiry into failures. It is based on the unsuccessful treatment of 8 cases of carcinoma of the esophagus during the past year.

Three cases were treated by inserting a tube of platinum containing 10 mg. of radium into the center of the growth for thirty-six hrs., i.e., (360 mg. hrs.,) and applying erythema *x*-ray doses around the growth with 100 kv. and aluminum filter of 3 mm. This treatment failed in 3 cases, and all the patients are dead. Three other cases did not return for treatment and 2 cases have been treated with *x*-rays from 200 kv. and one is still alive.

Carcinoma of the esophagus has, up to the present, been a lingering form of death. No treatment has done anything to cure it. The surgeon prolongs the patient's miserable existence by making a gastrostomy and feeding him through the artificial opening. I believe there are a few successful cases on record of an artificial tube of skin having been made, short-circuiting the carcinoma and so keeping the patient alive for a year. These measures do not cure the carcinoma, and the only possible hope of cure is held out by the use of radium and deep *x*-ray therapy.

I made use of radium in 3 cases mentioned by placing a tube of radium in a small catheter and leaving it in position in the center of the carcinoma. The radium is in a platinum tube which can be seen with *x*-rays, and thus its position in the middle of the growth can be easily determined. The cases in which I have done this have swallowed better after the treatment than before, but eventually all died. The improvement in swallowing I have ascribed to mechanical dilatation rather than to the effect of the radium.

Since deep therapy came in I have attempted to influence the growth by means of *x*-rays produced by 200 kv. The first case was one of carcinoma of the esophagus involving the larynx. Three and a half erythema doses were given by cross-fire to the neck over the carcinoma.

Two weeks after the treatment the patient could swallow meat. After a month, however, she had difficulty again in swallowing.

One month after her first treatment the skin of the neck over the region of the growth was red and peeling in front on the right side and behind. On the left side half an erythema dose had been given and the skin was not affected. The hair fell out at the lower part of the scalp behind. This patient had received 3½ erythema doses by cross-fire. She had a small neck and I calculated that 240 per cent of an erythema dose had been given to the growth. Two months after the first treatment, the patient did not appear to be improved. She was very weak and could swallow liquids only. Every time she swallowed, a little liquid went into the larynx and caused her great distress. By bending forward she could swallow a little better than in any other position.

Treatment was begun four months ago, when she had reached the stage at which liquids would not pass down the esophagus. When a patient reaches this stage he usually will not live longer than three weeks. This case, however, recovered so far that she was able to swallow meat two weeks after the first treatment. Today the condition of the patient is bad. She swallows, but is in a very low condition and is likely to die soon.

This case was particularly suited for deep therapy. The diagnosis was made by an experienced laryngologist. The growth was in an ideal position for cross-fire. The neck was small and fairly long. Three and a half erythema doses were given. Erythema and peeling followed on three areas and hair fell out. Therefore it was plain that the patient had received the dose. The rays were filtered through ¾ mm. of copper on each occasion and the skin focus distance was

---

* Read at the Midwinter Meeting of the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J. Jan. 25–27, 1923.

16 in. The kilovoltage was 200 to 210 and 5 ma. Time one hour for erythema dose. The half erythema dose was given to the left side of the neck with a lower voltage and its effect is not likely to be great in comparison with the doses given with 200 kv. The treatment was repeated six weeks after the first treatment. Two months after the first treatment the patient could swallow liquids, but was much distressed while doing so because of the liquid entering the larynx. I tried to get her to allow a tube to be passed so as to prevent liquid from entering the larynx, but she preferred to die rather than have that. The failure in this case was due to ulceration into the larynx, and a tube for the passage of food would have been the only remedy.

The rays may have influenced the growth, but the result has been a failure. I would not have repeated the dose if the patient had been doing well, but she was not doing well six weeks after the first treatment. The ulceration into the larynx may have been the cause of death.

My calculation of the doses she received is 240 per cent erythema dose on the first occasion and the same on the second occasion. The skin of the neck became very brown, but there was no vesication.

It may be the carcinoma received an overdose, yet a rodent ulcer heals well after giving three erythema doses, so why not give as much to carcinoma? My failure, however, does not discourage me. I have faith in the treatment and shall advocate it, until I either make a success of it or find out the cause of its failure.

I advocate it because it is the only case of early carcinoma that I get to treat and feel justified in treating. Any other early carcinoma should be removed by surgery, but in carcinoma of the esophagus the surgeon is helpless, except to do a gastrostomy.

Dr. Reginald Morton of London reports a case of carcinoma of esophagus treated by deep therapy alive over a year after the treatment. One successful case is sufficient to warrant every case of carcinoma of the esophagus receiving the same treatment.

With a machine that delivers 200 kv., using 5 ma. and 3/4 mm. of copper at a distance of 16 in., I find I get a mild erythema in one hour and an intense erythema in an hour and a half. In opposition to every one else, I use a pastille to measure my dose. I use a Corbett's tintometer and lay a pastille on the skin. At the end of an hour's treatment the pastille has colored to the half tint of the tintometer. This is a mild erythema dose. I admit up to 20 per cent error in dose by this measurement, but one must also admit 25 per cent difference of reaction with different patients. If therefore I give 20 per cent overdose to a 25 per cent over-sensitive patient, I shall have given an erythema dose and a half. This will not be serious and will not cause much discomfort. The pastille integrates the dose where it is given, in a way that no other instrument does. I have used the pastille to measure over 1,000 doses during the last year, and I have not yet found it to fail, either for epilation of ringworm or for deep therapy. In every case I lay the pastille on the skin at right angles to the incident ray. Armed with a pastille and a Corbett's tintometer I would not hesitate to go to a strange deep therapy machine and deliver an erythema dose without any previous practice. Although I am assured by the makers of my deep therapy outfit that there is a stabilizer supplied, I find that my milliamperemeter will not stay at 5 ma. for an hour. The change noted is from 4 to 6 ma. The pastille looks after this variation and integrates it.

Another advantage of the pastille is that I can supervise the work of treatment by its means. I have three treatment machines, and at the end of the day my assistants who have done the treatment lay on my desk each patient's index card of treatment with the pastille attached. My assistants estimate the dose from the pastille and note it on the card and I examine each pastille and confirm the dose.

My voltage is measured by balls of 12.5 cm. diameter and it is interesting to note that the E. S. G. between blunt points varies according to this chart. In summer the humidity of the air is higher, and in winter it is lower, as the air is very dry.

Before closing, and wishing to encourage others to use deep therapy for treatment of carcinoma of esophagus, I present to you a table showing the dose delivered to the esophagus at the level of the 7th cervical, 4th dorsal and 11th dorsal vertebrae, using 200 kv., 5 ma., 16 in. S.F. distance, surface square of 6 in. side, ¾ Cu. filter calculated from Dr. Mutcheller's tables and Symington's cross section anatomy.

AT LEVEL OF 7TH CERVICAL VERTEBRAE

Position	Depth, cm.	Percentage Dose
Front......	3½	75.99
Side.......	5	71.13 × 2 = 142.26. Total 278.95
Back......	7½	60.78

AT LEVEL OF THE 4TH DORSAL

Position	Depth, cm.	Percentage Dose
Front......	6	69.73
Each side..	10	51.58 × 2 = 103.16. Total 254.16
Back......	7½	60.78

AT LEVEL OF THE 11TH DORSAL

Position	Depth, cm.	Percentage Dose
Front......	8	60.78
Each side..	10	51.58 × 2 = 103.16. Total 220.10
Back......	9	56.16

I therefore cannot claim any success in treatment of carcinoma of the esophagus by deep therapy, yet I believe this treatment will be successful and I strongly advocate its use. I urge it because of the results I have had from treatment of carcinoma deeply seated elsewhere. My experience of carcinoma of uterus and adnexa treated with deep therapy confirms the findings of others. It has amazed me as well as my confreres.

I am indebted to Dr. Brooks for making the calculations for the tables, and for the diagrams.

DISCUSSION

Dr. Lewald. There is one case alive ten years after a surgical cure, in which the esophagus was actually resected. I have seen the specimen and have seen the microscopical slides. It is an adenocarcinoma of the esophagus and it is true that that case is surgically cured. The esophagus was resected as far as about the second thoracic space and then a tube inserted into that. The patient masticates the food and it passes into the tube and goes into the stomach through a gastrostomy. An attempt to reconstruct the rest of the esophagus has been advised, but the patient has been so comfortable that she refused to have it done.

About the spark-gap reading: We also noticed that the sphere gap is decidedly off in exceedingly high humidity. At 90 per cent humidity the sphere gap is far from correct.

CARCINOMA OF THE FLOOR OF THE MOUTH *

BY DOUGLAS QUICK, M.B. (TOR.)

Attending Surgeon, Memorial Hospital

NEW YORK CITY

INVESTIGATION of the surgical literature reveals little recognition of carcinoma of the floor of the mouth as a distinct clinical entity. British and American writers have usually grouped it with intraoral lesions in general, and as such it has received no special attention. The French have, for the past fifty years, devoted considerable attention to it as a distinct surgical problem. Verneuil's[1] paper on "Epithélioma des glandes sublingual" in 1871 is the first publication on the subject, and as the title indicates, he considered it primary in the sublingual salivary glands. Margnat,[2] in his Paris thesis of 1877, elaborated on Verneuil's work and in 1886 Feuilletard[3] made Richet's method of operation the subject of his thesis. In 1902 de Robillard[4] wrote a thesis on the operative procedure first outlined by Faure in 1897. Since 1907, Morestin[5] has made several reports on the operative procedures of choice, and, from a surgical standpoint, has undoubtedly given more attention to the subject than other contributors.

Unfortunately, little has been written about the clinical characteristics of the disease. It is with the hope of adding something to this phase of the subject and correlating it with treatment that this paper is presented.

Carcinoma of the floor of the mouth presents a clinical picture so definite that it can readily be recognized, even in late stages of the disease after extension to adjacent parts has taken place. The lesion begins almost invariably in the mucosa of the anterior half of the floor of the mouth and usually just at the side of the frenum of the tongue. The rate of growth is rapid. Potentially malignant growths of long duration, such as are not infrequent on the tongue, are practically never met with in the floor of the mouth. In our experience, all the cases have been of the squamous-cell type. While the papillary form of squamous carcinoma occurs here, it represents only a small minority: the infiltrating type is the rule. The disease establishes itself early and deeply in the musculature of the floor of the mouth, and, since the anatomical arrangement facilitates extension, the depth of infiltration is relatively greater than in any other group of intraoral carcinomas. This feature has added uncertainty to the surgical procedures and is equally baffling in determining the depth to which radium should be inserted. Upon more than one occasion I have thought I was dealing with a deep, fixed, submaxillary lymph-node, only to find at operation the deeply infiltrating base of the primary growth representing what I had thought to be the node. In those growths beginning at the side of the frenum of the tongue, extension to the opposite side is rapid. This creates essentially a "double" lesion. It necessitates a more complicated course in treatment of the primary growth. It makes a wider lymphatic dissemination possible, and if ligation of vessels is necessary, it must be done on both sides rather than one.

---

* Read at the Midwinter Meeting of the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J., Jan. 25–27, 1923.

A peculiar characteristic of the disease is the infiltration of the tongue from below upward. This is not necessarily accompanied by extensive ulceration of the mucosa of the tongue until late in the course of the disease. Hence, only palpation will reveal it. This tendency to upward extension into the tongue is even more marked than that of infiltration downward along the muscular planes of the floor of the mouth. Possibly the rich blood supply and freedom of motion of the tongue are contributory factors. I have seen a growth of this type show no clinical evidence of backward and downward extension posterior to the molars until ulceration appeared at the base of the tongue at the side of the epiglottis.

These growths usually arise in the mucosa at the inner or lingual side of the floor of the mouth, and this probably accounts for the early medial rather than lateral extension. They do, however, extend laterally both by direct extension in the mucosa and by infiltration along the muscles attached to the lower half of the inner surface of the mandible. When this is complete, the floor of the mouth is solid and invasion of the jaw along the line of muscular attachment is frequent.

While I am opposed to surgical removal of any intraoral carcinoma, I have nevertheless tried to maintain for statistical purposes a fair classification of surgical operability. In our series of over 100 cases, I have not seen more than a half dozen that could be considered operable from a surgical standpoint.

Extension to the lymph-nodes is frequent and early. The submaxillary nodes on the side of the primary growth are most frequently involved. If the growth has extended beyond the midline, the danger of lymphatic dissemination is of course much greater. Next to the submaxillary group, the jugular node of the upper deep cervical chain overlying the carotid bulb is most frequently involved.

The possible contributory causes of carcinoma of the floor of the mouth are interesting. Since the lesion almost invariably occurs in the anterior half of the floor of the mouth, the heat from smoking must be considered. This feature is strengthened by the fact that the disease occurs very rarely in women. Leucoplakia bears the same relation here as elsewhere—that of a chronic irritant. It is, however, relatively infrequent in the floor of the mouth. On the other hand, it is in this location somewhat macerated from constant bathing by mouth secretions and probably more dangerous. The constant motion of the structures forming the floor of the mouth undoubtedly aids in irritating and disseminating the disease, once it is established. The constant bathing by oral secretions and food debris is a source of irritation where ordinary cleansing is neglected.

Bad teeth are a factor only indirectly by contributing to the general uncleanliness of the mouth. Ill-fitting lower dental plates, on the other hand, are a real source of direct irritation.

The treatment of this disease has until recently been largely surgical. Escharotic pastes are not well adapted to use on moist surfaces. The various heat methods have been used considerably, but from a theoretical viewpoint, at least, are incorrect in principle. Except in rare instances, it is impossible to get around the growth with a cautery, while placing of the heating agent centrally does not insure complete destruction within the limits of safety. Heat paralyzes the vessels at the periphery of its field of activity and hence tends to increase dissemination of the disease if any peripheral focus remains. The isolated reports of single or small groups of cases are not sufficient to warrant any practical conclusions. For the most part the same is true of reported results of surgical removal.

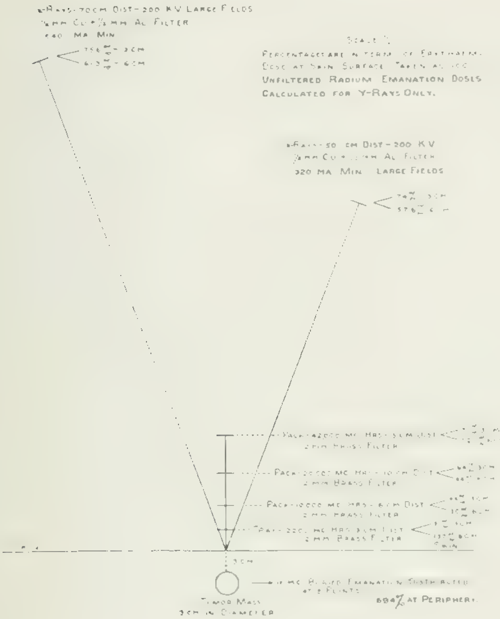

X-Rays-70cm Dist-200 KV Large Fields
640 MA Min
Unfiltered Radium Emanation Doses
Calculated for Y-Rays Only.
X-Rays-50 cm Dist-200 K.V
320 MA Min Large Fields
Tumor Mass
3cm
694% at Periphery

Fig. 1. Diagrammatic representation of varying intensities of radium and x-ray doses. Note the marked superiority of buried emanation over all external applications.

In 1909 Butlin[6] reported 9 cases occurring in his own practice and concluded that carcinoma of the floor of the mouth was not as dangerous to life as was generally supposed. He did not advocate any standard procedure, but applied the same excellent principles which prevailed throughout all his intraoral work. Of the 9 cases, 4 died of local recurrence, 1 of recurrence in the cervical nodes, and 4 were successful. Of these, 2, with movable lesions at the frenum of the tongue, had the cervical nodes removed shortly after removal of the primary growths and were well three years later, at the time of his report. One case was well ten years after without removal of nodes, and the other, twenty-two years after, without removal of nodes. It is obviously unfair to draw conclusions from such a small group, but it is interesting to note that his best results were in the two early cases without interference with the cervical lymphatics.

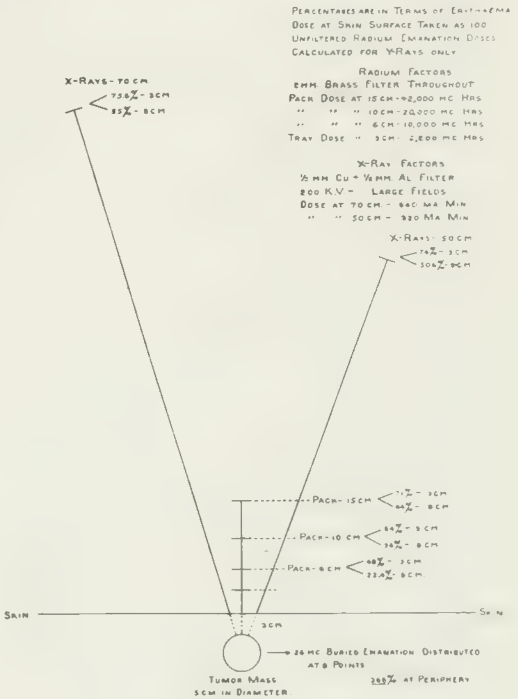

- Scale ¼ -
Percentages are in Terms of Erythaema
Dose at Skin Surface Taken as 100
Unfiltered Radium Emanation Doses
Calculated for Y-Rays only
Radium Factors
2mm. Brass Filter Throughout
Pack Dose at 15cm-42,000 mc Hrs
" " " 10cm-20,000 mc Hrs
" " " 6cm-10,000 mc Hrs
Tray Dose " 3cm- 2,200 mc Hrs
X-Ray Factors
½ mm Cu + ½mm. Al Filter
200 K.V.- Large Fields
Dose at 70cm.- 640 MA Min
" " 50cm - 320 Ma Min
X-Rays-70cm
75.6%-3cm
55%-8cm
X-Rays-50cm
74%-3cm
50.6%-8cm
Pack-15cm
71%-3cm
64%-8cm
Pack-10 cm
64%-3cm
34%-8cm
Pack-6cm
40%-3cm
22.4%-8cm
Skin
Skin
3cm
26mc Buried Emanation Distributed at 8 Points
Tumor Mass 5cm in Diameter
205% at Periphery

Fig. 2. Same as Figure 1, but showing relative values for a larger tumor.

In the strictly surgical field, Morestin's work is the most extensive. He has advocated a standard procedure which he has varied and amplified from time to time, always, however, maintaining the same principle—that of going as far from the disease and as near to the spark of life as possible. Briefly, his procedure was to split the lower lip, remove the upper half of the mandible on both sides as far back as the first molars, the mucosa and musculature of the floor of the mouth wide of the disease, a portion of the tongue and the cervical lymphatics. This left a good deal of healing to take place by granulation, but he counted on the remaining bridge of mandible to maintain the symmetry of the face and reconstructed mouth as far as possible. Later he divided his operation into two or three stages, removing the lymphatics first in one or two stages and finally removing the primary growth. While Morestin undoubtedly devoted a great deal of attention to this type of disease, he had but few cases to report. In his 1912 report he stated that to date he had seen only 11 cases in which his procedure was applicable. Of these, 3 never came to final operation, as they refused more than the cervical ablation or had unfortunate results after the preliminary work. Of the remaining 8, 1 died of bronchopneumonia following operation, 2 were lost track of, 1, free from cancer, died of pulmonary disease. Of the 4 cases followed, 1 had a recurrence after two years, 1 was well over four years, 1, nearly four years and 1, fourteen months.

In our own work we are opposed to surgical removal of the primary growth in this group of cases, for various reasons.

In the first place, only a small percentage of cases are, when they apply for treatment, amenable to a procedure even as extensive as Morestin's. Of these, only a part are able physically to stand the operation, even then running the risk of a high operative mortality. This leaves the great bulk of the cases on our hands in the very beginning. The mutilation of the operation itself, granting a favorable outcome, is enough to make both patient and surgeon shrink from it.

Aside from these practical factors, there are theoretical considerations. The trauma

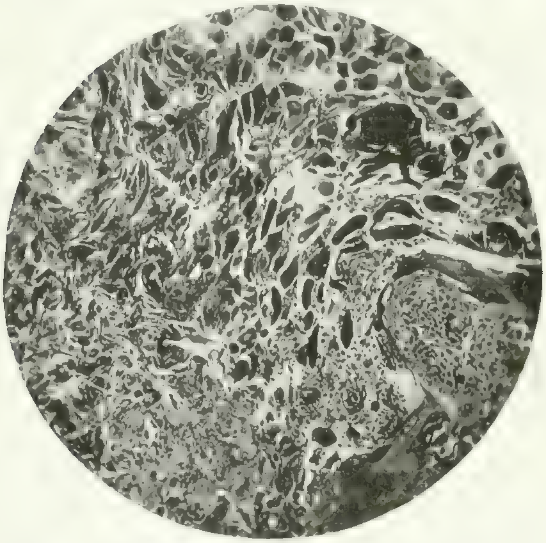


FIG. 3. Cervical node treated by maximum dosage of external radiation and removed one month later. Active tumor cells still present.

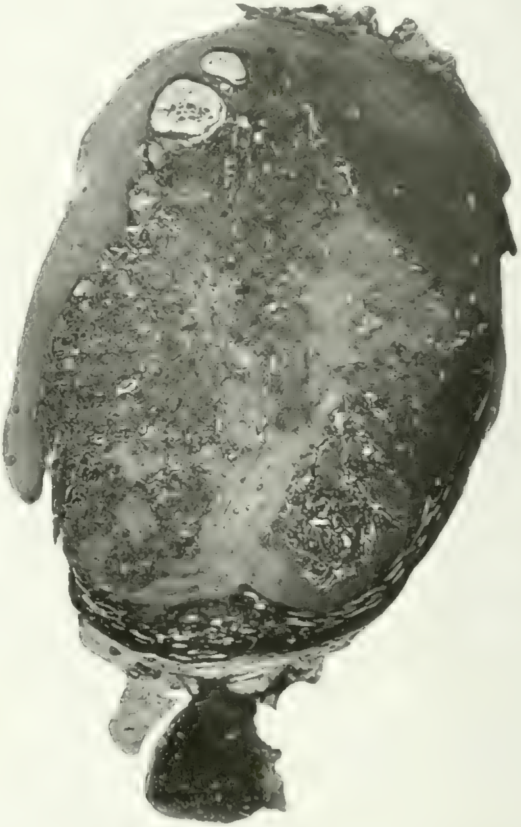


FIG. 4. Cervical node treated by buried radium emanation tubes and removed three weeks later. Complete destruction of tumor tissue.

incident to surgical removal in this location may very well disseminate more trouble than the knife removes. Any effort at local removal of a nonencapsulated growth, at least, only serves to destroy the defensive agents of the body— lymphocytes and plasma cells which are thrown out as a barrier round about the periphery of the growth. It has also been shown that loss of blood facilitates more rapid growth in any remaining focus of disease.

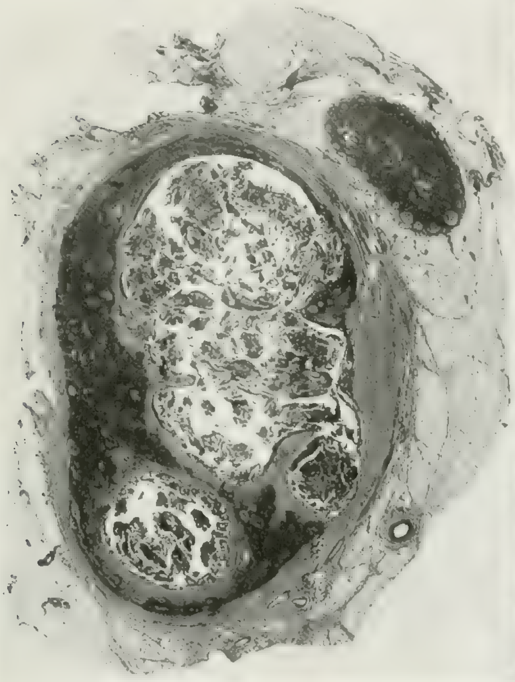


Fig. 5. Cervical node treated by buried radium emanation and removed one month later. Complete destruction of tumor tissue.

When we began using radium in intraoral cancer several years ago, favorable effects on tumor tissue were noted. When, in 1916, we began burying radium emanation in tumor tissue these favorable effects became much more marked. Palliative results not previously seen were obtained, and with improvement in technique of radium application went improvement in results. It was only reasonable to suppose that a method which would produce these changes in advanced cases would give much better results in earlier cases. Consequently we withdrew surgery from the primary intraoral lesions in favor of radium. We now feel, after over six years' experience, that this course has been amply justified.

In advocating the use of physical agents for the treatment of carcinoma of the floor of the mouth, mention must be made of *x*-rays as well as radium for their share in the work. In fact, I have been prompted to make this report at present for the purpose of calling attention to the lack of correlation of the two agents

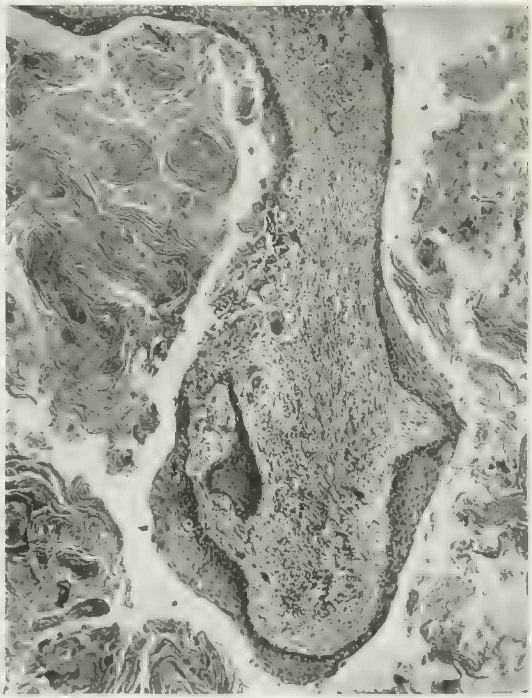


Fig. 6. Higher magnification of portion of capsule shown in Figure 5. Note the marked lymphocytic infiltration.

in some quarters. In dealing with this disease, these two agents form an excellent combination, and while I have seen complete regression of the disease from radium alone, I cannot say the same of *x*-rays. While I believe that *x*-rays are quite equal to radium for the external application, I must also say that I have never seen complete regression of a primary carcinoma of the floor of the mouth, by external application alone, of either agent. Neither have I seen what I would consider an authentic report of such a case. The fibrosis produced by repeated doses, while tending to inhibit the growth of tumor cells, also protects those surviving from subsequent applications of external radiation. There is a popular impression at present that the only requisite for complete regression of this type of disease is the uniform delivery throughout the tumor of a so-called "cancer dose." My own experience has been that it takes several times this amount of radiation to cause a clinical cure of epidermoid carcinoma.

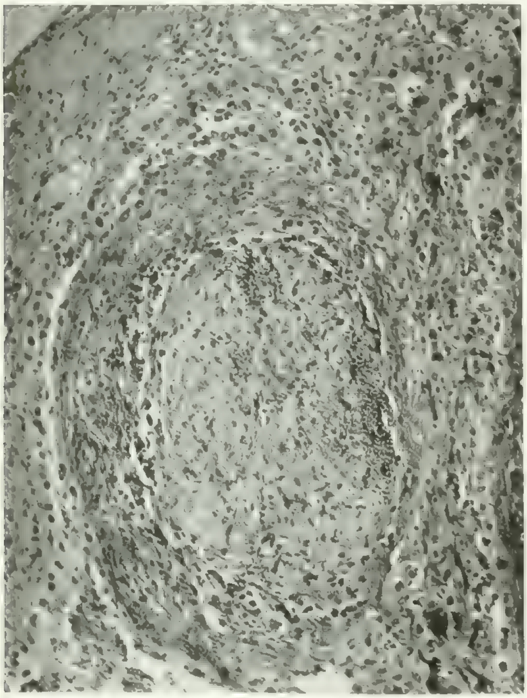


FIG. 7. Cervical node treated with buried radium emanation and removed two months later. Note fibrosis and lymphocytic infiltration.

In common with all intraoral carcinomas, the treatment of those arising in the floor of the mouth should be considered in two parts: First, treatment of the primary lesion; second, treatment of the cervical nodes.

In treating the primary growth we employ unfiltered tubes of radium emanation buried uniformly throughout the involved area, being especially careful to place them well to the limits of the palpable infiltration. A description of these unfiltered radium emanation tubes, their method of distribution, method of estimating dosage and advantages over interstitial use of needles containing radium element, can be found in previous publications.[7] These tubes should be placed so that there is, as nearly as possible, one tube per cubic centimeter of tumor tissue. This of course varies with the size and shape of the neoplasm. The preferable strength per tube is approximately one millicurie. Weaker tubes do not afford sufficient gamma radiation unless a larger number are used, and this produces too much trauma. Stronger tubes cause an excessive amount of necrosis. A study of the diagrammatic drawings in Figures 1 and 2 will show the relative values of the different forms of external radiation ordinarily employed, and their comparative relation to a safe dose of buried emanation. This estimate of buried emanation considers only gamma radiation and takes no note of the beta ray effect, probably one of the most important factors in interstitial radiation. It is also a very conservative calculation because the number of point sources is lower than that used in actual practice. It will be seen from these diagrams that the gamma ray effect alone from the dose of buried emanation is three to four times as great as the strongest cross-fire of heavily filtered radium at 10 cm. and 15 cm. distance or high voltage *x*-rays at 50 cm. and 70 cm. distance. These two latter are approximately the same in their efficiency. Smaller doses of heavily filtered radium at closer range are inferior to both. The tubes have not, in our experience, caused trouble as foreign bodies. There are, however, some disadvantages from their use in this location. Bathed as it is by mouth secretions in the most dependent portion of the oral cavity, infection is always present and the chronic inflammation adds to a radium inflammation which in itself is quite painful. As a result of this, the slough may be more extensive than with corresponding lesions in other locations. Wherever the slough tends to be deep the external carotid artery on the involved side, or on both sides if the lesion extends beyond the midline, should be ligated just above the superior thyroid branch. To reduce the anastomotic circulation to a minimum the lingual and facial arteries should be tied separately. This procedure can be readily done under local anesthesia, and produces no undesirable after-effects. Whenever the neck is opened for this purpose, radium emanation should be buried in the lymphatic tissue at the upper and lower angles of the wound as well as about the posterior portion of the submaxillary lymphatics.

In burying emanation in the floor of the mouth, it is practically always necessary to place tubes near the mandible, and this frequently results in devitalizing a piece of the adjacent bone. The separation of this sequestrum is slow and often painful, but to date we have found no way of avoiding it or of facilitating its removal.

In the treatment of the cervical lymphatics we favor a conservative procedure. Our views on this subject are stated in greater detail elsewhere, but may be briefly reviewed as follows:

We believe that the cervical lymph-nodes perform a conservative function in controlling and limiting dissemination of the disease, at least in the earlier part of its course. We also believe that metastatic extension of the disease is by embolism. The distribution of involved lymph-nodes and frequent single involvement of nodes secondary to intraoral carcinoma strongly support this view. Many of the patients applying for treatment are physically unable to undergo an extensive routine bilateral block dissection. In view of these considerations, we do not do a routine block dissection on each case as it comes to us. Instead, we treat each neck as a routine, with *x*-rays, for two reasons: First, to aid the lymph-nodes both directly and indirectly in the destruction of tumor cells and stimulation of the protective defenses of the body cells, thus combating secondary extension of the disease, and to produce at least a partial obliteration of lymph channels; second, to supplement the treatment already given to the primary growth. If at this time the neck is free from palpable involvement we do nothing more than use *x*-radiation or heavily filtered radium externally and keep the case under observation. If an invaded node is present, or appears under observation, we do a unilateral block dissection under local anesthesia and bury radium emanation at all suspicious points in the wound.

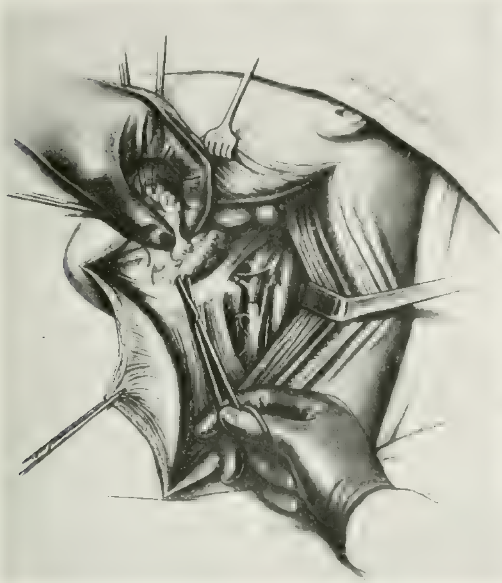


Fig. 8. Third stage of neck dissection. Note points of ligation of vessels.

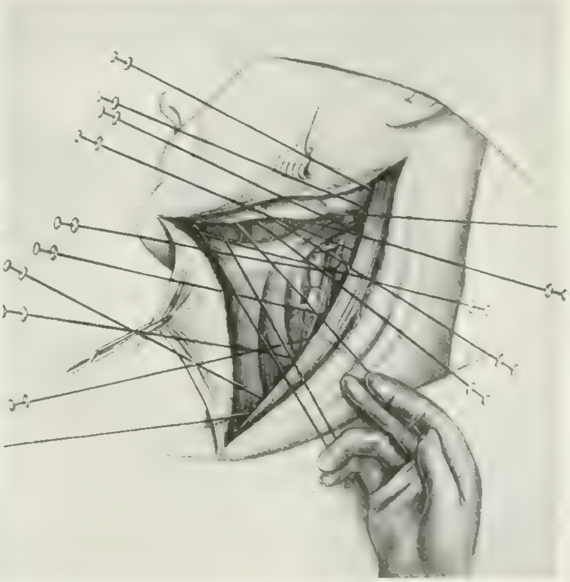


Fig. 9. Fourth stage of neck dissection. Note method of inserting unfiltered radium emanation tubes into base of surgical field.

If a node or group of nodes in which the disease has already perforated the capsule of the node, is present, we expose the nodes, bury radium emanation uniformly throughout them and close the wound. The latter group is proving to be a very interesting study, and while there is not sufficient data at present to report on it, I believe it justifies the hope that we may ultimately replace all cervical lymphatic removal by interstitial radiation. Whenever the neck is exposed surgically, either for dissection or implantation of emanation tubes, advantage should be taken of the exposure to ligate the vessels if the primary lesion is not entirely healed. The same exposure often offers an added chance to bury emanation through the submaxillary space into the base of the primary growth. Emanation tubes may often be buried directly from without through the submaxillary region to the base of a deeply infiltrating primary growth, but not as accurately as with surgical exposure. Similarly in advanced cases with bulky cervical nodes where only very temporary palliation can be hoped for, the tubes may be buried directly through the skin. For accuracy, however, surgical exposure is usually necessary.

In all cases an estimate of the possibilities to be reasonably hoped for should be made before instituting treatment. If complete regression of disease can be anticipated, it is justifiable to use doses to the limit of tissue tolerance, even at the expense of considerable reaction on the part of the patient. If only palliative relief can be expected, then the comfort of the patient should hold first place throughout, and dosage and methods be modified accordingly.

In presenting our statistics of this group of cases for the past six years, we do so fully realizing their limitations. The cases were unselected and were treated as they came to us. All but a very few were far advanced and many of them would probably have been better off had treatment been confined to oral hygiene and opiates. The series can in no way be compared with surgical statistics from selected cases. Since technique has been gradually improved, we feel that better results are now obtainable than were possible in the beginning of the series. The period of observation in the majority of cases is too short to permit of absolute conclusions.

During the period from January 1, 1917 to December 31, 1922, we treated in all 113 cases of carcinoma of the floor of the mouth. These were divided as follows: Primary without palpable involvement of cervical nodes, 35 (of these, 10 cases subsequently developed infected nodes); primary with involvement of cervical nodes, 65; recurrent locally, 6; recurrent in cervical nodes only, 5; recurrent both locally and in cervical nodes, 2.

In attempting to classify these cases it may be well to explain that when we refer to palliative relief, we mean definite relief from symptoms for a time, at least, and prolongation of life over the natural course of the disease for a period long enough to make the procedure well worth while. Quite a number of cases listed as such are still living and enjoying reasonable comfort under the circumstances, a few up to two and three years. Cases referred to as unimproved are those in whom there was no relief from symptoms or alteration in the natural course of the disease sufficient to make treatment worth while. In referring to neck dissections we mean a complete unilateral dissection followed by implantation of radium emanation in the wound—in a few cases only a submaxillary or a sternomastoid dissection was employed. Surgical exposures for ligation of vessels or implantation of tubes only, are not listed as neck dissections.

The division by years is as follows:

In 1917, 4 cases; 2 were improved and 2 unimproved.

In 1918, six cases; 1 now free from clinical evidence of disease 52 months, 4 improved for a time and 1 unimproved.

In 1919, 16 cases; 4 are now clinically free from disease for periods of 44, 42, 39 and 34 months, 8 were improved and 4 unimproved.

In 1920, 21 cases; 9 are now clinically free from disease for periods of 34, 33, 31, 30, 30, 29, 27, 27, and 26 months, 8 were improved and 4 were unimproved.

In 1921, 17 cases; 6 are free from clinical evidence of disease for periods of 20, 19, 16, 16, 12, and 12 months, 9 were improved and 2 unimproved.

In 1922, 34 cases; 4 are free from clinical evidence of disease for periods of 10, 8, 8 and 4 months, 11 have been improved, 5 were unimproved and 14 are too recent to classify.

Of 41 neck dissections done, 24 are now clinically free from evidence of disease, but this must be discounted because 10 were done in 1922, and several of the cases belong in the group of cases too recent to classify. Of the 30 done in the five years previous, 14 are now free from clinical evidence of disease. Only two cases put down in our records as clinically free from disease throughout have since recurred, one in 1920 and one in 1921.

Fifteen cases in the entire series showed secondary involvement of the mandible, and it is probable that this number would be higher had a routine *x*-ray examination of the lower jaw been made in every case.

Of the series, 37 cases are now known to be dead, 18 cases were totally unimproved, and 20 cases have been lost track of.

The net beneficial results from the total series of 113 cases to date are as follows:

Twenty-four cases are clinically free from disease for periods ranging, with one exception, from eight to fifty-two months; the average for the group being twenty-five and a half months.

Forty-three cases have been given palliative relief and of these 18 are still living.

Fourteen cases are too recent to classify.

CONCLUSIONS

1. Carcinoma of the floor of the mouth is a distinct clinical entity with peculiar therapeutic problems which render it unlike any of the other intraoral groups.
2. We believe our experience to date warrants us in advising interstitial radiation by means of unfiltered radium emanation tubes as the agent of choice in the treatment of the primary lesion.
3. We believe that the problem of dealing with the metastatic extension of disease to cervical nodes is best handled on a conservative basis, using a combination of surgery, radium and *x*-rays.
4. We make these tentative conclusions fully recognizing our limitations of observation period, number and type of cases treated.

BIBLIOGRAPHY

1. VERNEUIL. Epithélioma des glandes sublingual. *Bull. Soc. de chir., Par.*, 1871, xii.
2. MARGNAT. *Thèse de Par.*, 1877.
3. FEUILLETARD. *Thèse de Par.*, 1886.
4. DE ROBILLARD, J. Du cancer du plancher de la bouche. *Thèse de Par.*, 1902.
5. MORESTIN, H. Epithélioma du plancher de la bouche. *Bull. Soc. de chir., Par.*, 1908, xxxiv, 985–991.
   Cancer du plancher de la bouche: *Bull. Soc. de chir., Par.*, Apr. 13, 1910, xxxvi, 389–391.
   Cancer du plancher de la bouche: *Bull. Soc. de Chir., Par.*, May 22, 1912, xxxviii, 759–763.
6. BUTLIN, H. T. The results of operations for carcinoma of the tongue, with an analysis of 197 cases. *Brit. M. J.*, Jan. 2, 1909, i, 1–6.
7. QUICK, DOUGLAS. Treatment of carcinoma of the tongue. *Ann. Surg.*, June, 1921.
   The conservative treatment of cervical lymphatics in intra-oral carcinoma. *J. Am. M. Assn.*, Aug. 6, 1921, lxxvii.
   The value of interstitial radiation. AM. J. ROENTGENOL., Mch., 1922, ix, pp. 3,161.
8. EWING, J. Neoplastic Diseases, New York, 1919.
9. JANEWAY, H. H. Treatment of cancer, particularly of the tongue, tonsil and rectum, by buried emanation. AM. J. ROENTGENOL., Feb., 1920, vii, 92.

DISCUSSION

DR. PFAHLER. I am sure we all appreciate this very excellent paper of Dr. Quick, who has presented to us so carefully an analysis of his results.

I would like to emphasize the importance of cleaning out the mouth at the very beginning of the examination, getting rid of infected teeth, irritating plates, etc.

I have had no experience in the use of the emanation needles; therefore, I cannot discuss it from that standpoint at all. The results shown are certainly very convincing.

It has been the opinion of Dr. Widman and myself that we obtain our best results by the surface application, externally, of the roentgen ray, and now, of course, we are using higher voltage rays. Mr. Failla has worked out very nicely the depth value of this surface radiation. Most of these tumors are not probably 3 cm. in thickness, and therefore we will deliver a greater quantity to the tissue involved. It has been our custom, therefore, to apply roentgen rays externally to the limit of skin toleration and to apply radium by application over the surface of the tongue and floor of the mouth inside, and then after about a month, after we have had considerable fibrous tissue formation, to imbed radium needles into the tumor tissue, very much on the same basis as that on which Dr. Quick uses the emanation needle. We have used element needles (10 mg. needles) and used one needle for each c.c. of tissue involved and leaving the needles in place for a period of six to ten hours, depending also upon the size. We have this one advantage in the use of radium element needles over emanation needles: that we are using only the hardest beta rays and gamma rays, and we are getting distant radiation effect to a considerable degree. On the other hand, we have not as many needles to distribute and we cannot get as wide a distribution of radiation effects as you get with emanation. The emanation needles, however, produce more local necrosis and therefore you have liquefaction processes, which we avoid.

I simply mention this application to those who do not have emanation needles to work with. We only have 500 mg. of radium to work with and therefore have not thought it advisable to reduce it to emanation.

Dr. Ewing. In regard to the use of these highly destructive agents in cancer, it seems to me that the ultimate position which they will occupy in comparison with surgery depends not so much on any particular skill or technique but more upon the principles on which they are employed. I have encouraged my clinical colleagues to proceed with the use of radiation on the ground that the methods were biologically sound, and especially with the local use of radium emanation needles in the treatment of infiltrating squamous cancer.

There is an impressive parallel between the action excited by radiation properly applied and that which nature produces against the disease. If those observations are correct, then you may say that radiation therapy is secundum naturam, in accordance with nature's methods. Therefore, we can say radiation is to some extent a rational therapy. I am under the impression that the ultimate position of radiation therapy will depend more upon the principles upon which we are proceeding than upon development of technique. We are dealing with the disease on a more rational basis than has ever been employed in the treatment of cancer.

Is there such a thing as immunity against cancer? From experimental data we have certain grounds for assuming that there is actual immunity against the progress of certain malignant neoplasms. Experimental conditions under which supposed immunity has been observed are that after regression of a tumor in the animal he becomes more resistant to implantation of the same tumor—at times completely resistant.

Does regression of cancer under radiation in the body, with absorption of the regressing cells, increase immunity? I do not think we have any definite clinical observations to justify such an assumption but we do have sound theoretical data to encourage us to believe that there may be some increased immunity. Our information is far from sufficient to enable us to draw positive conclusions on this matter. This general immunity reaction, which we may assume to exist, is an element entirely lacking in any other method of treatment of cancer, especially surgery.

Dr. Quick (closing discussion). I have nothing more to say except to reinforce one point which Dr. Pfahler made; that of heavy surface radiation prior to the imbedding of either radium tubes or needles. We try to carry this out in all cases and feel justified in doing so because it does cut down the danger.

Another point in the difference between burying emanation and radium needles relative to the beta ray effect: I am not in a position to say that it is an advantage to have beta radiation present. We do know that it produces a very sharp local effect. In my own experience I think it has been unusual to note that those cases with the most permanent result have been the ones associated with beta as well as gamma radiation.

None of the agents today form the ideal cancer cure, so-called. Consequently I think it is our business to correlate them as far as possible, to take care of the local problem, and still keep looking for the various ways to take care of the real problem, that is, dealing with the thing constitutionally.

INTRATHORACIC CHANGES FOLLOWING ROENTGEN TREATMENT OF BREAST CARCINOMA*

BY T. A. GROOVER, M.D., A. C. CHRISTIE, M.D., AND E. A. MERRITT, M.D.

WASHINGTON, D. C.

AT the midwinter meeting of the Eastern Section of this Society, held in January, 1922, one of us (Dr. Groover) in the course of a discussion on roentgen therapy of malignant disease, reported certain intrathoracic changes that we had observed, following treatment of breast carcinoma.

These changes were also referred to by us in a paper read in the Section on Radiology, Southern Medical Association, Nov. 14–17, 1921, and published in the *Southern Medical Journal*, June, 1922, Vol. xv, No. 6.

We had an impression at that time that some of these changes were due to the treatment instead of to extension of the original disease. This impression has been strengthened by observation of other cases and the further course of those then under treatment.

This communication is presented only as a preliminary report, and to stimulate discussion. We are convinced, however, that not all the changes observed in the chest after massive dose treatment of carcinoma of the breast are due to malignant disease: that at least some of them are attributable directly to the effect of the treatment.

Our attention was first called to this by the fact that patients given prolonged treatment through a copper filter behaved quite differently from those treated by the older method through 5 or 6 mm. of aluminum over numerous portals of entry. The skin reaction after treatment through copper filter is marked at ten days and reaches its maximum at about eighteen to twenty; it then gradually subsides with a fine branny desquamation and is complete in from four to six weeks. About the time that the skin reaction is distinct, the patient begins to complain of a dry hacking cough, and in some cases, of difficulty in swallowing. The latter disappears in about a week or ten days, but the cough persists, and when the skin reaction has reached its height, the cough is very hard, dry and unproductive and causes the patient much distress. During the time of subsidence of the skin reaction the cough gradually lessens in severity and in six to eight weeks disappears entirely. The fact that the symptoms of intrathoracic irritation follow so closely the course of the skin reaction seems very significant. Their coincidence in a considerable number of cases has led us to the belief that the delivery of a large dose to the deep structures by means of prolonged treatment through a copper filter has brought about changes in the pleura and even in the lungs, analogous to the changes that take place in the skin. This belief seems to us thoroughly rational, especially in the light of investigations that have shown that roentgen treatment over the abdomen is capable of causing definite changes in the mucous membrane of the small intestine, accompanied by diarrhea and bloody stools. It is also known that a dose of roentgen rays sufficient to cure at one application an epithelioma on the cheek will often cause a very marked change in the mucous membrane of the mouth. The mucosa corresponding to the area treated on the outside has exactly the appearance it would have had if pure carbolic acid had been applied. The superficial mucosa is destroyed and sloughs off, leaving a normal-looking mucous membrane, these changes taking place coincidently with the destructive and healing process about the lesion on the outside. Similar changes are known to take place in the larynx, pharynx and esophagus after roentgen treatment about the neck. We have repeatedly observed extensive reaction over the mucous membrane of the fauces, soft palate, and pharynx after prolonged treatment for malignant disease of the face, mouth, or neck, the radiation being directed entirely from outside. It seems reasonable to believe that analogous changes may occur in the epithelial lining of the bronchi, the lining membrane of the pleural sac, or even in the parenchyma of the lungs.

---

*Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

Our observations are based entirely on clinical and roentgen findings and are not offered as definite proof that the phenomena are due to the effects of the roentgen ray. There is no way to demonstrate from our patients what histological changes are present, except as we infer from the roentgen appearance. Proof that the treatment instead of the original disease is responsible for the change, could be had if we could subject patients not suffering from carcinoma to exactly the same treatment. The procedure is of too severe a nature to permit of this, but it may be mentioned that we have treated 3 patients with sarcoma of the thorax, one of the 7th rib, one of the clavicle, and one of the soft tissues in the scapular region, and that all of them have had the cough described above when their reaction was at its height. In one there were distinct intrathoracic changes at the right base similar to those seen in the accompanying illustrations.

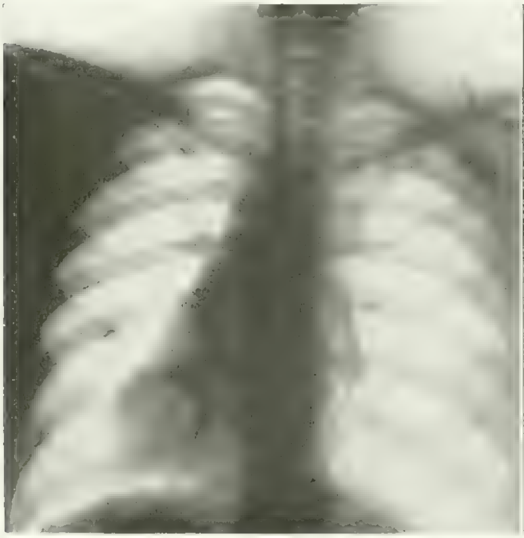


Fig. 1. Case I. May 4, 1921. Lungs are apparently normal.

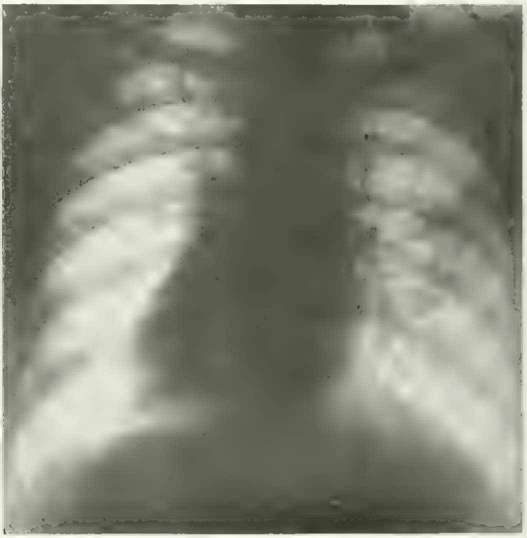


Fig. 2. Case I. July 7, 1921. Area of infiltration in right lung which was interpreted as a direct extension of the recurrent carcinoma of the breast.

We have been unable to carry out experimental work on animals, but we hope that this report will induce some one, properly equipped, to do it. We are aware of the work done by Warren and Whipple in the course of their studies of "Roentgen-ray Intoxication" which showed that the dosage used by them produced no demonstrable intrathoracic changes in dogs, while it did cause marked and extensive changes in the epithelium of the small intestine. The dosage used by them, however, by no means corresponds to that employed by us in treating breast carcinoma. Their dogs were treated through 2 mm. of aluminum, and the maximum dosage given was that represented by 512 ma. min., through comparatively small skin areas. Our total dosage directed toward the intrathoracic structures is represented by 2700 ma. min., and additional effect may be expected from the secondary radiation due to treating over large areas. It is only in the patients who have received these large doses that we have observed the symptoms and roentgen findings reported here.

The following case history, with reproductions of roentgenograms made at various times, illustrates the point we wish to bring out:

Female, unmarried, aged thirty-five, came under observation on April 30, 1921. Right breast removed June 3, 1920. A red spot persisted in the lower part of the scar, which, in a few months, developed into a rapidly growing tumor. It was conical in shape, about the size of a hen egg, very vascular, and projected outward from the chest wall. It was apparently near to ulceration. There was a definite palpable mass in the right side of the neck just above the clavicle. Roentgen treatment was given through ½ mm. copper and 1 mm. aluminum filter with a spark-gap of 9 to 10 in. and 5 ma. of current. The treatment was as follows:

April 30, 1921. The right pectoral region and axilla, including the area of the tumor, one and a half hours at 12 in. distance.

May 3. The same area as above for the same time.

May 4. The right side of the neck and supraclavicular region, two hours at 10 in. distance. A roentgenogram made on this date is shown in Figure 1.

May 6. Right scapular region, one hour at 12 in. distance.

May 7. Right scapular region, forty minutes at 12 in. distance.

May 10. Right scapular region one hour, twenty minutes, at 12 in. distance.

The patient thus had from April 30 to May 10 a total of three hours over the right pectoral region and axilla, three hours over the right scapular region at 12 in. distance and two hours over the right side of the neck at 10 in. distance.

May 28. Marked erythema over chest and neck.

June 9. Skin reaction subsiding. There is definite reduction in the size of the tumor and in the mass in the neck.

July 7. The tumor on the chest wall has almost disappeared. The patient complains of cough, which she has had for about three weeks. Roentgen examination of the chest on this date shows a definite area of infiltration in the right lung. The appearance suggests direct extension from the tumor on the thoracic wall, rather than metastasis (Fig. 2).

July 29. The external evidence of disease has practically disappeared. The general appearance is good, but there is considerable cough and shortness of breath on exertion. There is marked increase in the process in the right lung except that there is evidence of beginning fibrosis (Fig. 3).

August 19. No evidence whatever of disease externally. The expansion of the right chest is much restricted. The roentgen appearance is not essentially different from that of July 29 (Fig. 4).

September 13. The cough has almost disappeared. Still some embarrassment of respiration on exertion. There appears to be distinct retrogression in the process in the lung. There is evidence of fibrosis and there are adhesions at the base (Fig. 5).

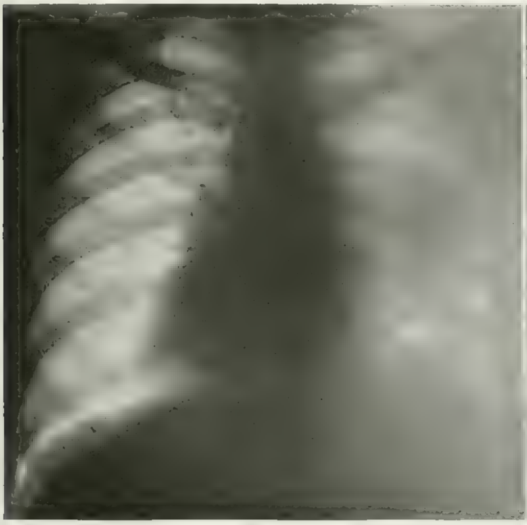


Fig. 3. Case I. July 29, 1921. Marked increase in extent of the infiltrated area.

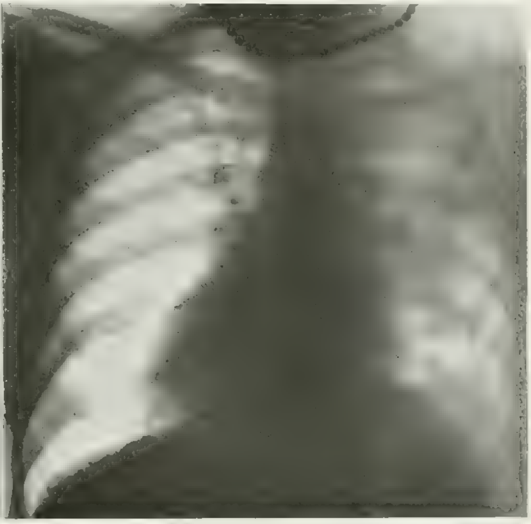


Fig. 4. Case I. August 19, 1921. The roentgen appearance not essentially different from that of Figure 3 except that there is beginning fibrosis.

September 29. The expansion of the right chest is restricted, the right diaphragm elevated and immobile and there has been gradual retraction of the heart and mediastinal structures toward the right. There appears to be distinct fibrosis in the right lung (Fig. 6).

The patient was lost to observation until May 23, 1922, when she reported again with an extensive local recurrence in the same location where the tumor was before. She states that this began to appear in February, 1922. There is now a large cauliflower mass with bad odor. Examination of the chest shows a much retracted lung field on the right side, but the lung aerates well and there is almost complete disappearance of the markings previously interpreted as representing fibrosis. There is no evidence of the presence of intrathoracic disease (Fig. 7).

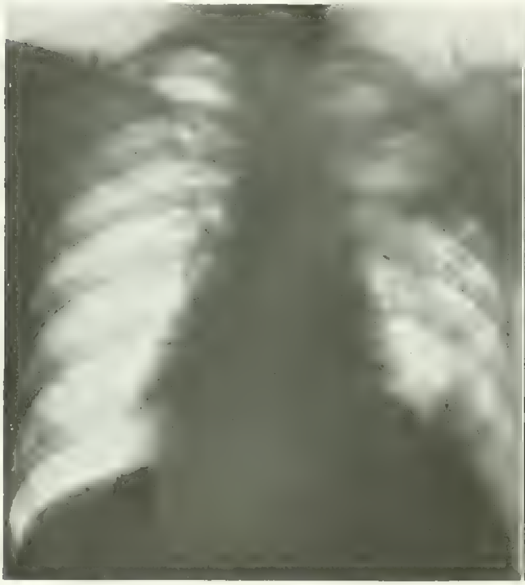


Fig. 5. Case I. September 13, 1921. The evidence of infiltration has largely disappeared. There are marked fibrosis throughout the lung and adhesions at the right base.

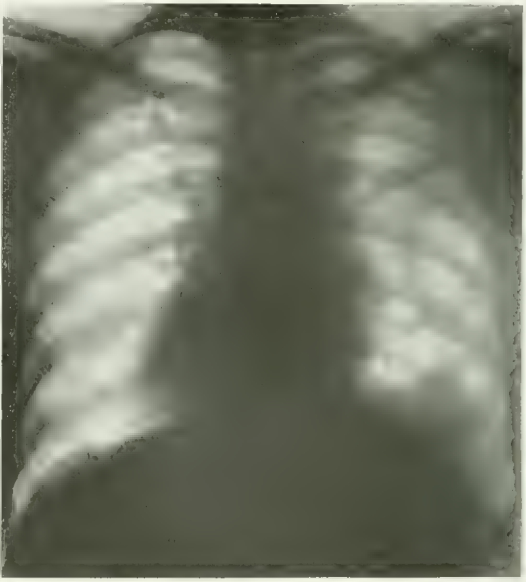


Fig. 6. Case I. September 29, 1921. Retraction of mediastinal structures toward the right. Right diaphragm higher than normal, and immobile.

On May 31 the tumor was removed by electrocoagulation and the area of the tumor given radium and roentgen treatment.

The points we wish especially to emphasize in this case are that this patient had a lesion in the right lung which appeared after roentgen treatment and was accompanied by cough and dyspnea; that this was presumably due to extension of the carcinoma of the breast, but that it subsequently disappeared; and that the patient is free today, after sixteen months, of any demonstrable intrathoracic disease.

Not all of our cases have been so clear-cut as this one. In some of them we are sure that there has been extension of the malignant disease to the intrathoracic structures. But even in these cases, the occurrence and subsequent disappearance of cough and dyspnea coincident with a partial clearing up of the evidence of infiltration in the lung have strengthened our conviction that roentgen treatment given in the way described does actually produce changes in the pleura and lungs.

DISCUSSION

Dr. Tyler. The lung changes following heavy radiation therapy have been noted by me for a considerable period of time. I agree with Dr. Christie in his description of the findings shown on the *x*-ray plate of the chest. In some of these cases the changes take place in the lung immediately following treatment. The changes can be demonstrated both roentgenologically and by physical examination, all of our cases having been checked up by all known diagnostic methods. If the changes come on acutely following the treatment, and treatment is stopped, the lung will gradually restore itself to nearly normal. There will, however, be left in the lung at the site of the lesion, scar tissue which is permanent and is demonstrable on the *x*-ray plate during the entire life of the patient.

Another type of case comes on very insidiously. The first symptom described by the patient will be shortness of breath. In this type of case the process is progressive, the scar tissue gradually increasing in the lung, and in some cases we have even had retraction of the lung from the chest wall without the formation of fluid in the pleural cavity. In others, we have had pleural effusion showing with contraction of the lung. In those cases the fluid, when drawn off, is straw-colored and is not bloody.

So far, we have been unable to get postmortem examination on any of these cases, although we have recently had two deaths in this type of case.

We note with considerable interest that Dr. Case calls attention to these changes in a paper read at the last meeting of the American Medical Association and published in the *Journal of the American Medical Association* for August 26, 1922, page 699. In the same number of the *Journal of the American Medical Association*, page 720, is an article by Dr. Laurence E. Hines of Chicago written under the title, "Fibrosis of the Lung Following Roentgen Therapy Treatment for Tumor." It has been his happy experience to get postmortem examination on two such cases, and he describes very interestingly the microscopic findings in the lungs of these patients which bear out the suggestions offered by Dr. Christie. In both of these cases reported by Dr. Hines, carcinoma was present in one and sarcoma in the other. Fibrosis shows, however, in both, with thickening of the walls of the bronchi, resulting in complete obliteration of the smaller ones as well as the terminal alveoli of the lung.

Dr. Stewart. It might be interesting for you to know that I have here a paper from Dr. H. Wintz, who probably has the most accurate roentgenological clinic in Germany. He states:

"By far more dangerous is the infiltration of the pulmonary tissue which may occur after systematic irradiations of mammary carcinomata or after raying of tumors located in the lung. The result of the examination of such a lung resembles that of a central pneumonia. There is no fever, but a slight irritative cough. For the respiration the whole affected part of the lung is, of course, useless. The condition is also comparatively harmless, and will recede spontaneously in the course of one-half to three-fourth years. But the concurrence of a disease (pneumonia bronchitis) would render the prognosis unfavorable."

Dr. Cathcart. Dr. Christie is to be congratulated for bringing to us at this time warning in regard to effects we may expect from deep roentgen-ray therapy.

I wish to report on two patients who, following breast amputation for carcinoma had local and cervical recurrences and were given deep *x*-ray treatment ($9\frac{1}{2}$ in. gap) to the point of skin tolerance over a period of about one year. Each developed a very irritating cough. Skiagraphs showed heavy fibrosis radiating from the hilus. This was thought to be malignant and treatment was discontinued.

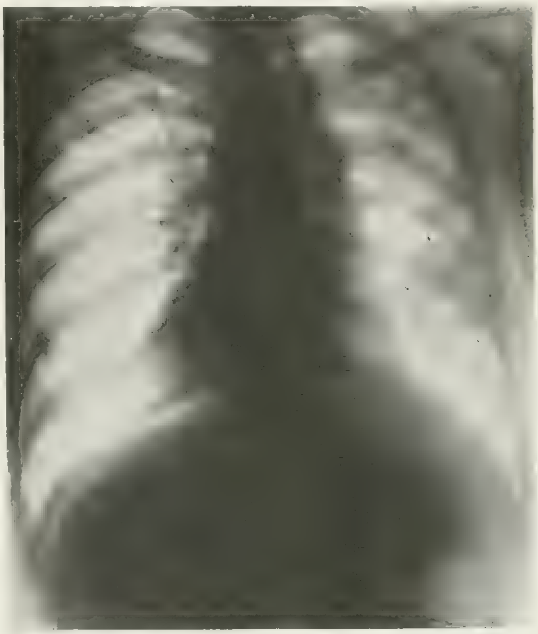


Fig. 7. Case I. May 23, 1922. Some fibrosis in upper part of right lung. Diaphragm in normal position and freely movable with respiration. The shadow indicated by the arrows is not due to intrathoracic changes, but to the recurrent tumor on the chest wall.

It is now one year since the last treatment. The cough has disappeared and radiographs show a marked decrease in the bronchial shadows.

Dr. Bissell. I wish to say that I have observed the same thing in three cases, and I followed them rather closely. They were all under observation at the time Dr. Tyler read his paper, and subsequent to that I followed them, and I want to say that it is not safe to speak of it as fibrosis. There is fibrosis left after the inflammatory reaction leaves. It acts like an inflammatory process, rather acute in its onset, and the patients have all complained of very severe compression of the chest.

I would like to ask of Dr. Christie: while these cases were radiated throughout the chest, in every instance the reaction was all on the one side. Why should it occur on one and not on the other? In my cases the reaction is always on the affected side.

Dr. Christie (closing discussion). Dr. Bissell suggests that we ought to emphasize the fact that it is not always possible, in any given case, to tell whether we actually have a metastasis in the chest or whether it is this infiltrative change due to treatment. Of course, it is not always possible, and as I said, not all of our cases have been so clear-cut as this one, because in some there were undoubtedly malignant changes.

I believe that the change is actually of non-infective inflammatory character, and that its final state is of fibrosis, that in the beginning it is infiltrative and actually an inflammatory change in the lung structure.

We believe that the coincidence of all these symptoms with the treatment proves quite definitely that the treatment itself is responsible for many of the changes we have observed.

A REVIEW OF THE PRESENT STATUS OF DEEP ROENTGEN THERAPY*

BY GUIDO HOLZNECHT, M.D.

Professor of Medical Roentgenology

VIENNA, AUSTRIA

SINCE Freund made his first attempt at the therapeutic employment of the roentgen rays, since Kienboeck first suggested the fundamental principles of roentgenotherapy, since the author (Holznecht) constructed the first dosimetric apparatus (1901), since Senn, of Chicago, with the roentgen treatment of leukemia, inaugurated the era of deep radiation, the problem of dosage has remained the center of our interest.

The question of dosage has not everywhere passed through a uniform development. In Germany it presents an aspect differing from that in America, France and England. The School of Vienna accepts some of the German results, while rejecting others and combining the experience gained in the past with modern knowledge.

The arrangement and standardization of dosage has to overcome two difficulties, namely, the physical and biological, both of which continue to receive new accretions through the ever-increasing knowledge regarding the physical and biological activities of the rays in the body, and, at last, through the overwhelming significance of scattering ("Streuung"). As regards the physical dosage, it seems that in principle it approaches a certain finality, which is of the utmost importance for the question of the biological dosage. As long as we are unable to weigh and measure the remedy, we shall be unable to get an exact knowledge of its biological effect.

We can study the status of both problems by directing our attention to the conceptions formed regarding them, which like land-marks indicate the road over which the investigation has traveled. Regarding the physical problem, we may follow Volz, whose conclusions, again, are based on the findings of other authors. With Volz we differentiate two general and three special dosimetric conceptions. Dealing first with the "physical dose" in the stricter sense of the term, we see that it does not take any cognizance of the bodily relations, nor of any manifestations exhibited during the passage of the rays through the body, and considers only the density and penetrative power of the rays by measuring and registering them.

Then the quotient of dosage, the proportion between the incident radiation and the radiation present at any depth: This conception, omitting nothing, comprises all effective factors, the kind of primary radiation, the focus-skin distance with its well-known significance, the portal of entry with its scattering effect and the qualities of the body. For practical purposes it seemed to be advisable to formulate two additional special dosologic conceptions. For the limitless variety of the respective factors necessitates the establishment upon concrete premises. The special conception of the "percentual deep dosage" is based on the focus-skin distance of 23 cm. at a depth of 10 cm. and a portal of entry of 6 to 8 cm. Leaving out of consideration the size of the portal of entry, the conception of the "effective dose" becomes amplified. Moreover, by leaving the focus-skin distance and the depth without a special determination, the result will be a measure which has been designated as "utility dose." The latter changes from place to place on the irradiated body, which we may imagine as being filled by the numbers of the doses. This picture will be endowed with system and order if we conceive of the points with equal doses as connected by lines. You are acquainted with these pictures of transverse sections which contain such a multiplicity of lines. These appear as the most interesting mohair-like designs, if we think of the body as irradiated not from one direction but from different sides, because then several additional dosage numbers become assigned to each point. Only by proceeding in this manner shall we be enabled to obtain a full insight into the distribution of the rays in the body. But we must not think of these doses as being in accordance with our old posologic conceptions—namely, quantities, but as intensities which are effective at any instant or in any unit of time. If these are summed up during the course of a radiation we obtain the "surface energy" and its distribution, and herewith an exact idea of the quantity of roentgen rays in the body. Simple as these results may appear, they represent a superabundance of work.

---

* Read at the Twenty-third Annual Meeting of The American Roentgen Ray Society, Los Angeles, Calif., Sept. 12–16, 1922.

We were not as successful with the investigation of the biologic dosage and its formulation. The conceptions "destructive dose," "paralyzing dose," "stimulating dose," "skin unit dose," "carcinoma dose," "ovarian dose," "tuberculosis dose," etc., have all been found wanting for practical purposes. Evidently, under the influence of a mechanistic natural philosophy, there has taken place what might be called a standardization of pathology which years ago met with scant favor. They all are of significance as working hypotheses, from which the investigation proceeds and advances, but for practical purposes none of them seem to be available, especially not the conception of the "effect of stimulation." Its value has been assured for the semen and the ova of lower and higher organisms, but it has not been proved for new growths. In spite of many thousand cases of cancer treated during the last twenty years with weak radiations, the numerous respective assertions are supported by only a few more closely observed cases of an apparent promotion of growth, and even if we were willing to accept them, they represent but exceptions from which no rules can be formulated. Moreover, it is quite improbable that the rays would exercise a purely depressive or purely promoting influence upon the living cell. Yet, it seems to be probable that there arise various "alienations" which, as a matter of course, may contain depressive or stimulative components. Science will continue to explore them, while for practical purposes we would better remain on the terra firma of facts and experience. How far one may go astray was made manifest when—from an over-estimation of the defensive forces of the organism, especially the connective tissue, against carcinoma—small doses were recommended and thus the precious acquisitions of our experience were jeopardized. For the treatment of carcinoma the high doses are to be continued. As to the exact amount of the doses, we have learned valuable lessons from the treatment of sarcoma. On the proper dosage in sarcoma, the statistics collected by Juengling (1905, 1912, 1914, 1920) have thrown light: 30 per cent of the sarcomata disappeared primarily; 50 per cent shrunk; 20 per cent remained absolutely refractory, no matter whether several millimeters of aluminum or brass and zinc were employed with the old or modern technique. Even without filtration, there were still 17 per cent of primary disappearance. We do not speak of a cure, but merely of primary disappearance, which is selected as an estimation of the effects of the different methods. All this goes to show that the

	Filter	Disappearance, Per Cent	Shrinking, Per Cent	Uninfluenced, Per Cent	Total Cases
Kienboeck, 1902–1905	None	17.8	57.8	24.4	90
Chr. Müller, 1912	Aluminum	31.4	45.7	22.8	35
Seitz Wintz	Heavy filter thin	31.4	48.6	20.0	70
Clinic Tübingen	Heavy filter thick	31.9	44.7	23.4	47

improvement in the technique above a rather low degree was of no avail. It is not we, but the particular form of tumor which determines whether our treatment will be successful or not. To remember this is important. It would not be right to torment the patient by exposing him to secondary effects, if we are unable to conquer the sarcoma by this method. I believe, maybe with some of you, that in the case of a carcinoma we are confronted by the same conditions, although of a higher technical degree. As sarcomata of the lymphatic glands are distinguished by their sensibility to a low technique, among the carcinomata those of the uterus are responsive to a higher technique. Of microscopically well-characterized sarcomata some disappeared primarily, while others remained refractory. The same observation has been made with the carcinomata. In spite of the most phenomenal results obtained in a few cases, the fact remains that all the technical improvements in the world will not enable us to triumph over the carcinomata absolutely. It is dignified to acknowledge our inability and to confess that we are confronted by a biological barrier over which to leap is not in our power. There remains nothing to be done but to find the still unknown technical degree for the carcinoma, which may possibly be accomplished by means of the modern therapeutic apparatus. This has always been our opinion regarding the other, especially the internal diseases which, owing to the interest devoted to the carcinoma, have been too much neglected. The standardization and determination of the dosage is difficult but important, for the practice requires normalization. If we form theories from our experience with the various affections, and write down the best technical measures, we shall find ourselves confronted by a chaos of various posologic prescriptions, if I am allowed to use this expression also in our department. They must, of course, contain technical factors, because the dosage is dependent upon them and even upon the intervals between the series. In order to simplify our task, the manifold affections and prescriptions must be first formed into several groups. And indeed, we can easily arrange the different affections in four groups, namely, those that require an extremely large quantity (where in solitude the carcinoma is enthroned); the sarcomatous and certain other affections requiring a considerable quantity; those requiring a medium quantity; those requiring a small quantity. If we want to prescribe uniform technical formulae for each group of diseases we shall find ourselves hampered by the differences in the size of the parts of the body and the varying depth of the tissue which call for different fields and different quantities. These difficulties may be overcome if, in place of the different sizes and forms of the parts of the body which are to be irradiated, we substitute a limited number of definite variations in their size. I propose five degrees of sizes, namely, parts of the body of approximately 5, 10, 15, 20, 25–30 cm. thickness. To these are to be adjoined, for each group of diseases, the corresponding number and size of the fields. The formula remains the same for each group. As a matter of course, some diseases require exemption from the general group formula. The hardness of the rays—which hitherto was measured by the spark gap or the number of kilovolts in the apparatus (both quite inexact) or in the absorption experiment with the "selenium cell" (simple but not exact); or with the iontometer (very cumbersome)—is now to be determined by the shortest wave-length and by the wave-length of the maximum of radiation. Both may easily and exactly be determined by means of the new spectrometer (March, Staunig and Fritz of Innsbruck). In employing the latter, we do without the photographic plate and read from a fluoroscopic screen. Our tabulation gives the hardness of the rays as well as indications of the spark-gap, the main data of the radiation mixture, the shortest wave-length and the maximum of radiation in "Ångström units."

I beg to submit to your judgment my proposition which has become feasible by the fact that during these latter years roentgenotherapy has made immense advances.

PRACTICAL ROENTGEN-SPECTROMETRY AND ITS PHYSICAL BASIS*

BY PRIVAT-DOZENT DR. K. STAUNIG

INNSBRUCK, TYROL, AUSTRIA

THE "qualimetry" of roentgen rays (determining the hardness, power of penetration, lengths of waves) must, as is easy to see, form the basis for every practical use of the rays in general and for the dosimetry of the roentgen therapy in particular. For, as it is impossible to recognize the value of large sums without knowing the value of the unit coin of this standard of currency, or, as the artillerist who does not know the range of his cannon, cannot reckon on the exact effect of his guns and runs the danger of damaging his own lines, so in the practical use of roentgen rays the knowledge of the power of penetration is a preliminary condition for the exact comprehension of any effect which the rays should produce.

We know, for instance, by experience, that each radiogram needs special conditions of exposure, according to the thickness and density of the object to be reproduced. Under these conditions the *quality* of the radiation is of decisive importance. What *quantity* of radiation is needed for a radiogram is of secondary importance. In the same way the roentgen penetration also needs a qualitative definition of the usable rays. Although empiricism has abolished grave mistakes and errors here, the choice of the suitable radiation, the reliable filtering and the statement of the appropriate quantity of this radiation for every substratum to be penetrated, will only be possible when the problem of qualitative analysis has found its solution. A burning question, however, is that regarding roentgen therapy. The rays have proved a medicine which has general and local effects. To dose this medicine means to give it in qualitatively and quantitatively fixed amounts. As long as the quality is not exactly ascertained, it is like a solution whose composition is not or is only inaccurately known. Nobody would care to prescribe such a solution, even if he had the means to dose it quantitatively, as, for instance, in c.c. Empiricism, it is true, by using rule of thumb methods, has formed a system which enables us to avoid injuries, and has been of great value; but this does not alter the fact that the real problem is still awaiting its solution, and that the unravelling must start from the point of the qualitative analysis of the radiation.

None of the methods used up to now led to the exact physical basis, that is to say, to the *knowledge of the wave-lengths of the radiation;* they had to be content with an insufficient approximation. So, for instance, the new method of filtering analysis has declared radiations as homogeneous, which really contained differences of a whole octave of wave-lengths, as was proved by Seemann's spectrometric experiments. The exact examination of measuring methods by the special committee of the German Roentgen Society has brought to light a whole series of sources of errors and defects, so that today we consider the whole structure of qualimetry as shaken, and must think of a complete new construction of the dosimetry.

A new system could be built up only with support of the method of ray-analysis, made use of by physics; especially as we had to deal with methods which had already brought unforeseen success in

---

*All researches on this subject have been carried on with the help of the Rockefeller Fund. Detailed literature in *Fortschr. a. d. Geb. d. Röntgenstrahlen.*

broad spheres of science. Clear and distinct as the results of the physical experiments were, especially as to exploration of the roentgen spectrum, still they have not attained that importance for practical radiology which they ought to have; partly because there was not enough attention paid to them, partly because the methods were really not adaptable for practice on account of their unhandiness and intricacy. It took up hours of exposing time, for instance, to project a spectrum; choosing an adaptable crystal and adjusting it needed such accuracy that it seemed to exceed the limit of what could be expected of a practicing physician. The physicist, however, was led by his own interests into exceedingly fertile regions, but regions which were far from the sphere of interest of the practicing radiologist. So the physicist went on his own way in ignorance of the needs of practice; the practitioner, on the other hand, overlooked or underestimated the importance of physical researches.

When, on this account, we, March, Fritz and the author, in the spring of 1920 started in Innsbruck to establish relations between the physics and the practice of radiology, the problems could be seen in distinct form. There could be no doubt that the crystal analysis had to form the basis of a spectral-analytic process and that the first problem was to find a practical form for it. It ought to make possible a direct insight into the roentgen spectrum; it ought to adapt itself to the conditions of radiological practice and its simple resources. It should be possible to carry it out in a short time and to repeat it as often as one wants to. It should be accurate enough, in spite of its simplicity, to make possible reasonably exact measurements of the wave-lengths. The second problem was the following: A single quantity which should be able to characterize with sufficient accuracy the polychrome complex of the radiations, had to be found for every spectrum, corresponding to a radiation. In other words, a key had to be obtained which could serve in practice as a simple term for each radiation. The third problem was the utilization of this key in practice. Before we proceed to give a short explanation of our spectrometric method of analysis, and to describe our spectrometer and its utility, we will give a short résumé of the results of the physical experiments, as they appeared to us at the beginning of our researches or were supplemented during the course of our work. This seems to be especially necessary, as these important results, though not unknown in radiological circles, were at least greatly underestimated as to their importance for radiology in general.

PHYSICAL BASIS

The spectrometric method of examination found its introduction in Laue's renowned experiment. In this, a bundle of primary rays penetrates a fixed crystal; the rays are reflected by numerous planes which are regularly studded with atoms. Each reflection takes place at a host of these planes, and the reflected waves blacken the photographic plate at the points where they meet it. The whole of these numerous meeting points forms the Laue-diagram.

The reflection of roentgen rays does not take place for all the wave-components which are contained in the bundle, but only for certain wave-lengths (λ), namely those for which Bragg's relation is valid.

$$\lambda = 2d \sin \alpha$$

In this equation α means the angle between the x-ray and the planes (glancing angle of incidence) d, the distance of two neighboring planes, the so-called lattice constant of the crystal. That is to say, a crystal chooses and reflects from a mixture of waves only those wave-lengths which bear the above-mentioned relation to the lattice constant and to the glancing-angle. The Laue-diagram, however, showed by the arrangement of the black points that wave-lengths of different sizes are reflected in the crystal and one could suppose that a continuous white spectrum exists, like the continuous white spectrum which one gets when analyzing sunlight. The arrangement of Laue's experiment, however, proved unsuitable for measuring the limits of this spectrum and the distribution of the intensities corresponding to the various wave-lengths in the spectrum.

Only Bragg's spectrometer gives the classical method of analyzing the roentgen spectrum. It does not use a fixed crystal and does not employ a lot of sets of planes (Laue), but the reflection is produced on one and the same set of crystal planes. By continually turning the crystal with respect to the primary ray in each case, corresponding to a certain angular position of the crystal, another wave-length is removed from the mixture of rays by reflection. In this way all the wave-lengths contained in the mixture can be reflected one after another, and the limits of the spectrum, as well as the distribution of the intensities, can be ascertained.

Experiments by Moseley and Darwin, according to Bragg's method, established besides the continuous white spectrum, still another spectrum, the so-called characteristic or line-spectrum which, as contrasted with the continuous spectrum, is not polychromatic, but monochromatic; that is to say, it consists only of waves of a single wave-length. The experiments proved that these waves of the characteristic spectrum are dependent on the nature of the anticathode metal. They are the shorter in wave-length, the higher the position of the anticathode metal is in the periodic system of the elements. So this second spectrum is, on the one hand, dependent on the nature of the anticathode; on the other hand, experiments have proved that the conditions of its origin are also connected by rules with the quality of the continuous spectrum. This last fact must be especially mentioned, as conclusions can be drawn as to the nature of the line-spectrum, from the analysis of the continuous spectrum, if the anticathode is known. In other words, the qualitative analysis of a roentgen radiation can rest on the analysis of the continuous spectrum alone, under the condition that the metal of the anticathode is known.

THE NATURE OF THE CONTINUOUS SPECTRUM

De Broglie was the first to analyze the continuous spectrum by Bragg's method, registering the reflected intensities of the single wave-lengths on the photographic plate; the black bands he obtained brought proof of the strictly continuous course of the spectrum for the first time; but, as Wagner has proved in detailed analytical experiments, they do not even approximately give the real course of intensity of the roentgen radiation in the spectrum, because, on the one hand, the long wave-length parts produce, on account of their greater absorption, blacknesses which are more intense than corresponds with the relative intensity with which these waves are contained in the spectrum. On the other hand, some bands which are sharply marked toward the long wave side of the spectrum and come from the selective absorption of the Ag and the Br, are still to be found in the blackness of the photographic plate. By these bands the real course of the distribution of intensity is still more distorted. To analyze the spectrum Duane and Hunt made use of the ionizing method which very nearly approaches to the real distribution of energy. These exceedingly important experiments laid the foundation for rules which are equally important in theory and in practice. For these reasons we will give them in order.

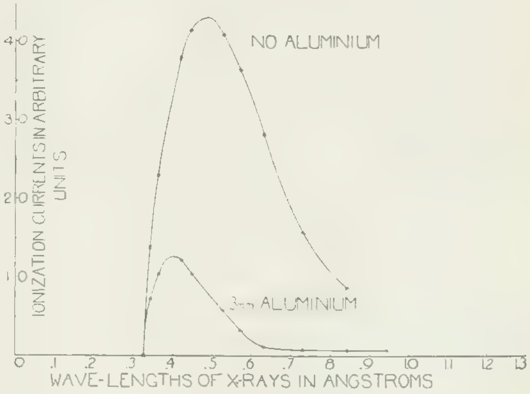


Fig. 1.

1. The first experiments of Duane and Hunt led to the fundamental discovery that the continuous spectrum is sharply marked toward the short wave-length side with a shortest wave-length λ (radiation head, minimum wave-length) (Fig. 1).

2. Duane and Hunt showed that from this beginning of the spectrum the intensities of the following longer waves rise

precipitously to a rather sharply marked maximum, that the intensities then diminish more slowly toward the long wavelength side and fall off asymptotically toward the end, beyond the limit observation.

3. They found that a certain potential, V, corresponds to the shortest wavelength λ; by changing the potential, V, they found a displacement of λ in the spectrum, according to a simple rule which is called "Duane and Hunt's law of displacement." The higher the potential one applies to the tube, the more the short wave-length boundary is displaced toward the side of the short waves. This was in keeping with the roentgenological knowledge that the more short wave-length components appear in the radiation, the higher the tension applied. Duane-Hunt's law now says that the product of the shortest wave-length and the potential is a constant K, whose value is 12.300. That is to say, if the potential is known, then the shortest wave-length of the roentgen radiation is also defined; and vice-versa: if the shortest wave-length is known, the potential is given which has produced the roentgen radiation.

The simple formula for this rule is $V . \lambda_o = V \frac{c}{\nu} = K$ and is in exact agreement in the form $V = \nu_o \left(\frac{K}{c}\right)$ with the Planck and Einstein's quantum equation: $eV = h\nu$. The result of this is that $\frac{K}{c} = \frac{h}{e}$[1].

By these researches the quantum character of the radioproduction in the anticathode was cleared up at once. We mention this for the reason that we shall see farther on that March could deduct important conclusions from it as to the distribution of energy and the formation of the radiation.

Duane and Hunt's law of displacement was corroborated several times by experiments; A. W. Hull and Rice followed its accuracy up to 100,000 volts; Dessauer and Back, up to a tension of 170,000 volts. The last two authors found, for instance, at 170 kilovolts the minimal wave-length = 0,07055 AE, while Duane-Hunt's law requires the value λ_o minimum = 0,072 AE. The agreement of the corresponding values of λ_o proved even exact enough to carry out accurate measurements of Planck's radiation constant h.

4. Müller has demonstrated that Duane-Hunt's law of displacement is valid, independent of the metal of the anticathode; Wagner has confirmed this fact.

5. Ulrey has found out that the total intensity issuing from an anticathode increases with the second power of the tension (V^2), according to previous knowledge.

6. The same discoverer has ascertained that the form of the spectral course of intensity is extraordinarily similar, in practical sense the same for all metals of the anticathode.

7. Ulrey has further shown that the absolute intensities from the anticathode under the same conditions rise proportionally to the atomic number of the anticathode metal.

The most important rules of the continuous spectrum are thus shown.

8. March has given a well-considered theory for the formation of the spectrum of the roentgen radiation in the anticathode, and fixed its laws. Duane-Hunt's law has led March to suppose that the fate of the electrons, when putting on the brake, and also the formation of the continuous spectrum, is regulated by a process determined by laws. First he found out that the spectrum's form, that is to say, the distribution of energy, is chiefly determined by the fate of the fastest electrons, as the quantity of the transformed roentgen energy decreases as the fourth power with the diminution of the speed of the electrons which strike the anticathode. The fastest moving electrons are those which correspond to the vertex value of a current tension curve. If such an electron collides with the electrons and the positive nuclei of which the anticathode metal is certainly built up, its energy E, according to Planck and Einstein, is transformed into a radiation of such vibration number ν, that $E = h\nu$; that is to say, the produced wave is the shorter,

---

[1] V = potential; ν = maximal number of vibrations per second;
K = constant.
Velocity c = velocity of light (3.10^{10} cm./sec.).
e = charge of the electron ($4.774.10^{-10}$ e.s.)
h = Planck's constant (6.52×10^{-27} erg. sec.).

the vibration number the larger, the greater the energy which the electron loses in a single collision.

(*a*) Should the electron be stopped straight off, at a single impact, its loss of energy is the greatest one can have, and the wave corresponding to the tension is formed with the largest vibration number, which is precisely the shortest wave-length, λ_0 with which the spectrum is sharply marked off.

(*b*) But if the electron must go through several or many collisions until it stops, then at every collision it gets rid of part of its energy E, that is the energies E_1, E_2, E_3, etc.; these part energies, too, transform themselves into radiation and into radiation of such vibration numbers that Einstein's relation is fulfilled. We have, therefore, $E_1 = h.\nu_1$, $E_2 = h.\nu_2$, etc.

These waves ν_1, ν_2, ν_3, must all have smaller vibration numbers (larger wave-lengths) than the boundary wave-length, λ_0. They range, therefore, in the part of the curve beyond the minimum. From this can be seen that a single electron can produce either only one, namely the wave-length λ_0, or several longer waves than λ_0. The manner of the arrangement of the longer waves, in the spectral region, March recognized as taking place according to the laws of probability. That an electron loses its whole energy in one collision and the shortest wave-length is formed, will only seldom be the case, in comparison to those cases in which, in the regular structure of the anticathode, the longer waves form themselves in a *series* of collisions, that the energy transformed into radiation has a certain value E. The oftener this is the case, the greater will the intensity be with which the wave-length coordinated by Einstein's equation is contained in the spectrum. The curves calculated by March agree exactly with those found by experiment.

From these statements follows that not only the minimum wave-length, but also the distribution of energy in the spectrum can be deduced from the tension applied to the tube. In other words: by the statement of the wave-length λ_0 *every radiation gets its definite qualification.* This is very important in practice, as from it follows that the chief object in spectrometric analysis is to ascertain the size of the wave-length λ_0. This wave-length is that property of the radiation which gives it its character; if the metal of the anticathode is the same, then radiations of equal minimum wave-length are qualitatively equal to one another. If the metal of the anticathode is different, then the radiations differ through the linear intensive wave components of the characteristic spectrum, the quality of the continuous spectrum is the same. Therefore, the object of this practice in any quantitative use of a radiation is to pay attention to the nature of the A.C. metal and to ascertain separately the working effect (radiographic, biological working effect, dose quotient) of the radiations of platinum and tungsten or any other metal used as A.C.; the special quality, however, can always be determined by the wave λ_0., because the characteristic spectrum bears a definite relation to it.

THE ROENTGEN SPECTROMETER BY MARCH, STAUNIG AND FRITZ

1. *Physical Arrangement.* While Laue's method makes use of the inner planes of a fixed crystal, Bragg's method uses a superficial plane of cleavage of a crystal which is continually turned, and our scheme makes use of the third possibility of arrangement, that is, the reflection of a bundle of roentgen rays on the inner planes of a rotating crystal.

From this arrangement several advantages are gained immediately. The inner planes are untouched by outside influences, as contrasted with the outside planes, which are usually defective and damaged; their ability to reflect is more perfect. The use of a relatively thinner crystal has thereby no greater influence on the absorption of the penetrating ray bundle than the absorption which takes place if reflected according to Bragg's method. By our transferring the turning point of the crystal into the optical axis, that is, into the plane of the bundle of roentgen rays, every difficulty of centering the crystal is abolished, because in every position of the crystal that plane always sets in automatically which sorts out the corresponding wave-lengths from the mixture of roentgen rays according to Bragg's relation, as far as that wave is contained at all in the mixture.

As we are not bringing the reflected waves of the continuous spectrum to absorption on the photographic plate, but observe them in the fluorescent effect on the screen, we gain:

1. Direct insight into the roentgen spectrum, and can observe it without loss of time, without the roundabout way of developing the photographic film in the dark room and the sources of mistakes connected with it.

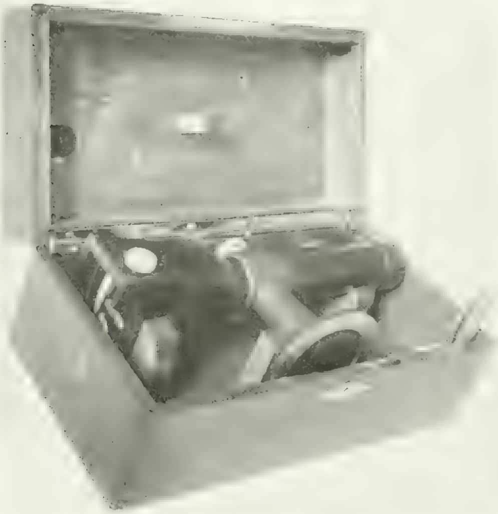


Fig. 2.

2. We can look into all parts of the spectrum for any desired length of time and can repeat the examination as often as we like.

3. The examination of different radiations of an apparatus, as is often necessary in practice, can be done immediately, and the whole productive power of an apparatus can be revealed within a quarter of an hour.

4. Through a particularly simple measuring mechanism we can ascertain the size of the shortest wave-length with great accuracy and read off directly from a scale in Angström units. The great exactness for reading is due to the fact that this shortest wave-length is ascertained, not from its distance from the primary bundle (which always has a considerable finite extension), but from the distance of the shortest wave-lengths of the two symmetrical spectra.

5. The great sensibility of the adapted eye allows the observation of the spectrum in the dark room (or with help of a cryptoscope in daylight) with amply sufficient accuracy.

6. The reproduction of the spectrum on the screen prevents the mistakes which are connected with the photographic plate, and allows a direct insight into the distribution of intensity of the spectrum, because the brightness of the interval sorted out in each case appears in proportion to the real intensity.

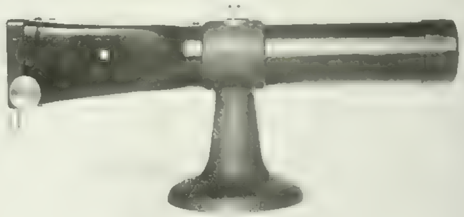


Fig. 3.

Of all these advantages, the possibility of exact observation of the sudden appearance and disappearance, and the measurement of the absolute size of the boundary wave-length is, by far, the most important, because with the knowledge of this wave-length, as we have seen, the qualitative analysis of a radiation is exhausted.

The technical arrangement of the instrument[1] which is enclosed in a small ray-tight box, can be seen in the drawing in Figure 2.

II. *Practical Utilization of the Spectral-analytic Method.* The spectralanalytic method has given a simple characteristic for every roentgen radiation in form of the size of the shortest wave-length, λ_m, which can be found easily. With this designation each single radiation, if the anticathode is known, is sufficiently characterized for practical purposes and defined according to its quality. Herewith a way is found which leads to fruitful results for practical roentgenology, for the definition of the quality of a radiation is of great importance for radiography, for the radioscopic method, for the use of the radiation in depth therapy, for the measurement of the effective tension and for judging the work done by the apparatus and roentgen tubes.

---

[1] The instrument may be obtained through the Spectrometer Vertriebsstelle, Zentral-Röntgeninstitut Innsbruck.

III. *Utilization in Radiography*. Experience has proved that each radiogram needs certain conditions of exposure in order to attain its best quality. These conditions of exposure are different for every thickness of the object and density of a part of the human body which is to be radiographed. If they are not observed the well-known poorly exposed plates result which we know as the "too hard" and "too soft" plates (mistakes of penetration or hardness) and the plates with too little or excessive blackening (under-exposure, over-exposure). Up to now the practitioner had to help himself with an empiric method to get the right values of exposure for all typical and atypical radiograms, because there was no sufficiently exact method of assuring the quality of a radiation. The practitioner had to create for himself by way of empiricism, a system of exposure with the help of a systematic procedure, for the apparatus he used; he had to make experimental exposures and, by slowly eliminating the errors in exposure, to try to obtain better and better plates and finally to get a perfect system of exposure for his apparatus. Now the testing of the apparatus has become much simpler, because with the aid of such a system of exposure empirically worked out, we could find out qualimetrically (by giving the boundary wave-length, λ_0) and quantimetrically (by giving the necessary milliampere second product) the conditions of exposure for all practicable adjustments in use.

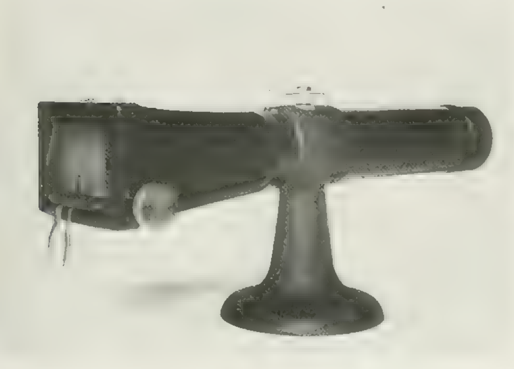


Fig. 4.

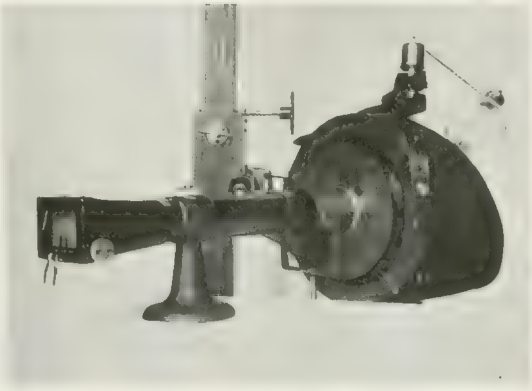


Fig. 5.

The new process of testing an apparatus is now accomplished in a much simpler way without the help of the empirical method; the radiations of the apparatus with the different settings are analyzed one after another as to their shortest wave-length λ_0, and this wave-length and the occasional milliampere deflection are registered (this procedure for a normal type of roentgen apparatus takes up a quarter of an hour). With the help of the tables worked out the densities of the different objects and the time values for exposure are added to the ascertained wave-lengths within a second quarter of an hour. That is simply done by dividing the milliampere-second product which is to be found in the table for every radiogram, by the number of milliamperes which are obtained at the proper setting. According as short-timed exposures are wanted, or longer lengths of time, one can get several systems of exposure. The roentgenograms obtained are free from exposure faults. The lengths of exposure have been fixed by us so far, for the Lilienfeld tube and the ion tube. It would be worth while, if they could also be ascertained for the Coolidge tube which is not at our disposal in Innsbruck. The tables accompany each spectrometer on delivery.

With the help of these experiments Fritz has discovered important qualities of the roentgen tube; there exist considerable differences between the amounts of current according to whether the ion tube or the Lilienfeld tube be used. To gain exactly the same photographic effect by the gas tube as by the Lilienfeld tube, at a given boundary wave-length, λ_0, the Lilienfeld tube needs double the number of milliampere seconds under the same conditions otherwise.

IV. *Utilization of Spectrometric Analysis for Roentgen Therapy.* Roentgen radiations can be used in therapy either as unfiltered or as filtered radiations; as unfiltered they are subject to the same qualitative definition as in radiography, namely, they are marked, by giving their boundary wave λ_0, as hard and soft complexes if the anticathode is known. This fundamental marking is valid in the same way for the filtered complexes, too, with the single difference that for these the kind of filtering (density and nature of the filtering metal) is still added to the statement of the *boundary* wave-length. First of all, it is clear that every radiation is connected with a certain effect on the surface and in the depth of the body. Until now it has not been possible to grasp this effect with sufficient accuracy because the quality of the radiations could not be surely defined. Only now, as enough accurate quantitative measuring methods are known, 'can the fixed standard of effects be allotted to certain quantities of a certain radiation. So for instance, for every unfiltered and filtered radiation, the allotted toleration dose for the skin is fixed once for all. Even the tolerance of the deep-lying normal organs of the body can be drawn into the region of observation. The biological effects which are produced on superficially situated pathological processes by different doses of the qualitatively defined radiations can only then be thoroughly studied. Above all, however, for deep therapy a most important point has to be considered: *in the case of a given quality of radiation the percentage of the dose reaching a certain depth can be fixed once for all by empiric measurement.* To measure these dose quotients for all radiations which are to be considered in therapy, and those for the different sizes of field and focus distances, was the goal for experiments which are now nearing their completion. It is easy now to find out the dose quotient for a diseased organ lying at a certain depth, because the tables worked out give the percentage which penetrates to the inner part of the body from a superficial field for every depth. The roentgen therapist, by choosing a suitable number of fields and by choosing a suitable geometrical system, is now enabled to achieve the necessary depth dose. Only now has the radiation become a therapeutic method, whose composition is known, and which can be given even quantitatively. The biological effect in the diseased organ itself and the general effect on the body only now enter into a reliable relation to the dose, and it will be the problem of the future to examine the many various results of empiricism by a more exact method of approach in this respect.

V. *Measurement of Tension.* For a long time it has been a well-known fact to every practitioner that the hardness of a radiation rises with increasing tension; Duane-Hunt's law has now shown that a surprisingly simple connection exists between potential and boundary wave-length. The laws revealed by Ulrey and March enlarge this connection still more, as they have proved the dependence of the quality of radiation on the potential. Therefore, the roentgen spectrometer by March, Staunig and Fritz can also serve as an absolute voltmeter; this qualification for the mentioned purpose is of great importance on this account, as the spectrometer measures just the tension which was led to the production of the radiation, therefore, that tension which alone is of value for the practitioner; for him it is insignificant how much tension the electrotechnical instruments show, if he cannot draw a reliable conclusion as to the quality of the radiation from the indicated number of volts. This he cannot do really; for on the one hand the tension is subject to great losses, especially if the values are high, losses which occur on the way between the source of tension and the electrodes of the tube; on the other hand one must not forget that every roentgen tube is a transformer of energy which can only exploit the potential up to a certain limit. Judging by the results achieved up to now, this limit seems to be different in magnitude for the different types of tubes. Therefore, in the spectrometer a means is given which enables even a practitioner to test the real efficiency of his apparatus. For him, only the wave-length is to be considered which the apparatus can produce at the short wave end of the spectrum. From it he can draw a reliable conclusion as to the effective tension, and any other tension is of no essential interest to him.

SUMMARY

Summing up the results of the spectrometric method in practice gained so far, we can say that the new process has already led to a far-reaching uniformity and a simplification of the methods in roentgenology. Although this method has been in use for only a relatively short time, still it can already be seen that it is of importance for all branches of radiology, and there is hope that its further development will justify the expectations. Of course, there will be no lack of objections to this method in the future. We believe that, especially at the beginning, the schematical process, as we have tried to give it, will meet with opposition because the objection may be raised that the *discharge of the tension curve*, which so far was thought to be of such great importance for the quality of the produced radiation in the different types of apparatus, cannot remain without considerable influence on the relative composition of each radiation, therefore on the curve of the spectrum. It really is the case that other forms of the tension course belong to the different types of tubes, the ion-tubes on one hand, and the Lilienfeld and Coolidge tubes on the other hand, since with the ion-tubes, it has to do with the appearance of an explosive tension which is absent in the electron-tubes. Therefore, on account of the different discharges of tension, for these types of tubes, the necessity has already resulted, of separately ascertaining the quantitative working power for each of the same, with regard to the emitted radiation. But it has been shown that even for these types the *quality* of the radiation, that is, the form of the curve of the spectrum, is not obviously different. On the other hand, the results of testing, gained up to now, and the theoretical calculations by March have shown that an influence—considerable for practice—of the current tension curve on the distribution of intensity, as has been ascribed to the different types of *apparatus*, is not due to them, or only in so small a degree that it is to be neglected for practical utilization of the radiations.

STANDARDIZATION OF IONIZATION MEASUREMENTS OF INTENSITY AND MEASUREMENTS OF SCATTERED AND SECONDARY X-RAYS EFFECTIVE IN PRODUCING AN ERYTHEMA*

BY J. L. WEATHERWAX, M.A., AND EUGENE T. LEDDY, M.D.

Radiological Department, Philadelphia General Hospital

PHILADELPHIA, PENNSYLVANIA

THIS paper is a preliminary report of some data obtained in the study of the intensity of penetrating *x*-rays as measured at various depths in a phantom of water. The reason for giving it is to provoke a discussion which we hope will result in certain standards of measurement of *x*-ray intensity being adopted.

We were interested in knowing the penetration of *x*-rays produced by our high voltage *x*-ray machine. The literature on measurements of intensity as delivered by *x*-ray bulbs was reviewed and comparisons were made of the intensity reaching a depth of 5 and 10 cm. below the surface of a phantom of water. Of all the work we have been able to review, the various investigators disagree among themselves as to percentages of intensity reaching a given depth in a phantom of water, having used the same set-up. We have tried checking some data that we found, but have been unable to obtain comparable results. In some instances our penetration percentages differed widely from those reported. We made a similar set-up to one used by Dr. Dessauer in reporting 55 per cent of the surface intensity 10 cm. below the surface. Our measurements gave us 43.5 per cent when we measured the surface intensity with the ionization chamber half submerged in a phantom of water. The average coefficient of absorption of water that we obtained for 200,000 volts, maximum, filter 1.3 mm. Cu. and 1 mm. Al. at 50 cm. from the target to the surface of the water, which is similar to Dr. Dessauer's set-up, was .137; while Dr. Dessauer reports that the coefficient of absorption of water, used in arriving at the value of 55 per cent was .140. This shows that the average wave-lengths that we were using were as penetrating as those used by Dr. Dessauer. In other reports of penetration measurements, the technique of the set-ups was such that we were unable to make checks. These inconsistent penetration experiments led us to investigate the variations, if any, of the surface intensity. Since penetration percentages are obtained by comparing the intensity on the surface to the intensity at given depths, it is necessary that we all have the same starting point. We will show that it is important to know definitely how the surface intensity is measured.

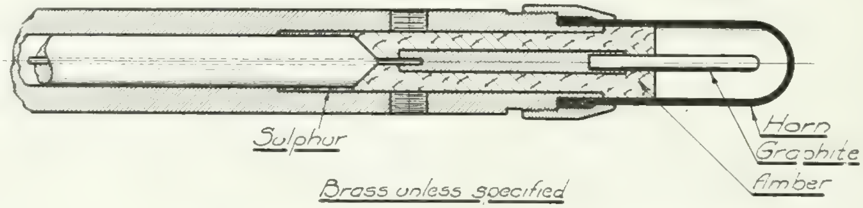


FIG. 1. Modification of Kroenig and Friedrich's ionization chamber.

Our ionization chamber was modelled after one used by Friedrich and Kroenig, except for minor changes. We chose this style of ionization chamber with the view of comparing our results with those reported by Friedrich and Kroenig, and because, on account of its size, intensity changes with small changes in position can be determined. Figure 1 shows the ionization chamber drawn to size. Figure 2 shows a schematic diagram of measuring apparatus as set up. The ionization chamber is placed under the center of the *x*-ray bulb in an open field, and the electrode connected to a wire in a flexible metal tube going through an 18-in. brick wall to an electroscope with a ground glass screen for observing the image of the gold leaf of the electroscope as projected by a lens. This separation by a brick wall keeps stray radiation from the electroscope and protects the operator in making measurements. The ionization chamber, flexible cable and electroscope are sufficiently well insulated to make possible measurements disregarding the natural leak of the system. The leak of the system is such that when charged to about 300 volts, the leaf of the electroscope will change its position on a screen 134 cm. distant at the rate of 1 cm. per hour and a half. As the time for the leaf to travel the same distance while taking readings is about 50 seconds as a maximum, the natural leak is less than 1 per cent. The electroscope was repeatedly checked with radium and found to be constant in readings to within .4 per cent as checked by various operators.

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25-27, 1923.

Our set-up was the same in all our work, consisting of 200,000 volts, maximum, 4 ma., 0.62 mm. Cu. and 1 mm. Al. (filter placed 30 cm. from target) and the distance from the target to the water surface was 50 cm. Figure 3 shows the various positions taken by the ionization chamber while readings are being made. The diameter of the cap of the ionization chamber is 12 mm., so that when the cap is placed on the surface of the water, the center line of the electrode is 6 mm. above the surface. When the cap of the ionization chamber is half submerged, the center line of the electrode of the ionization chamber is in line with the surface of the water. The distances 5 cm. and 10 cm. as shown in Figure 3, refer to the measurements made from the surface of the water to the center line of the electrode of the ionization chamber.

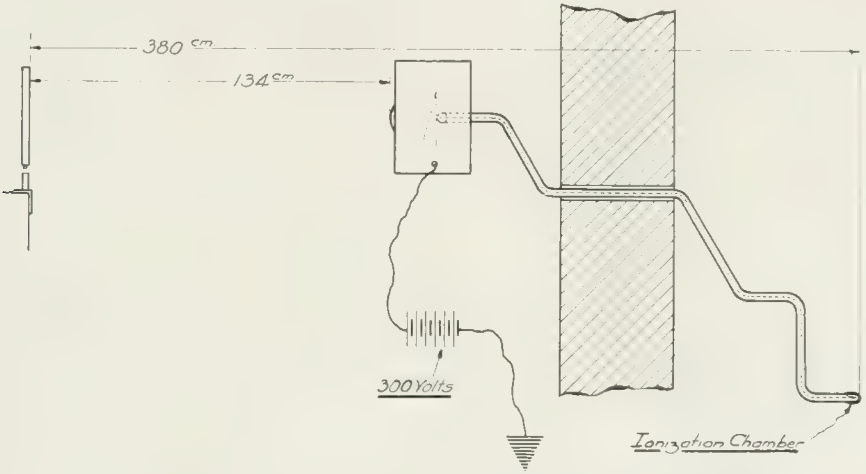


FIG. 2. Schematic arrangement of apparatus for measuring *x*-ray intensity.

Our method of taking measurements is to start out with the ionization chamber in air, and then to place the ionization chamber on the surface of the water, half submerged, fully submerged, 5 mm., 5 cm. and 10 cm. below the surface of the water. The path of the ionization chamber is then reversed as 10 cm., 5 cm. and 5 mm. below the surface, fully submerged, half submerged and on the surface of the water, and then in air. Two readings of each position are taken and these two sets of readings averaged. This makes at least four readings of each position. Twenty different determinations of percentages have been made for each position, making in all eighty readings for each position. Assuming 100 per cent for fully submerged, the position having the greatest intensity, the following is obtained:

Position	Percentages Variation, Per Cent
In air	66.4
On surface	95.7
Half submerged	98.5
Fully submerged	100.0
5 mm. below surface	97.7

It is seen that 33.6 per cent of the intensity is due to the scattered and secondary radiation produced by the water. The intensity of *x*-rays on the surface, then, is not only incident radiation in air but the scattered and secondary radiation produced by the water, or tissue, effective in producing an erythema. The variation on the surface may account for some of the variable results that are found in penetration experiments. What value are we to assume as our 100 per cent, or the intensity of *x*-rays effective in producing an erythema? When we began measurements, it seemed reasonable to place the ionization chamber half submerged in water, which means that the center line of the electrode is in line with the surface of the water. However, we see that there is a 1.5 per cent greater value fully submerged than half submerged, and a 4.3 per cent greater value fully submerged than on the surface. The ionization chamber going from on the surface of the water to fully submerged has moved away from the target a distance of 12 mm. and yet gives 4.3 per cent higher intensity. From the inverse square law, an increased distance of 12 mm. should decrease the intensity from 100 per cent on the surface to 96 per cent, fully submerged; but we actually get 104.3 per cent. There is then an increase of radiation of 8.3 per cent due to scattered and secondary radiation which is effective in producing an erythema. There is also an actual increase of intensity of 4.3 per cent from the surface of the water to fully submerged and if

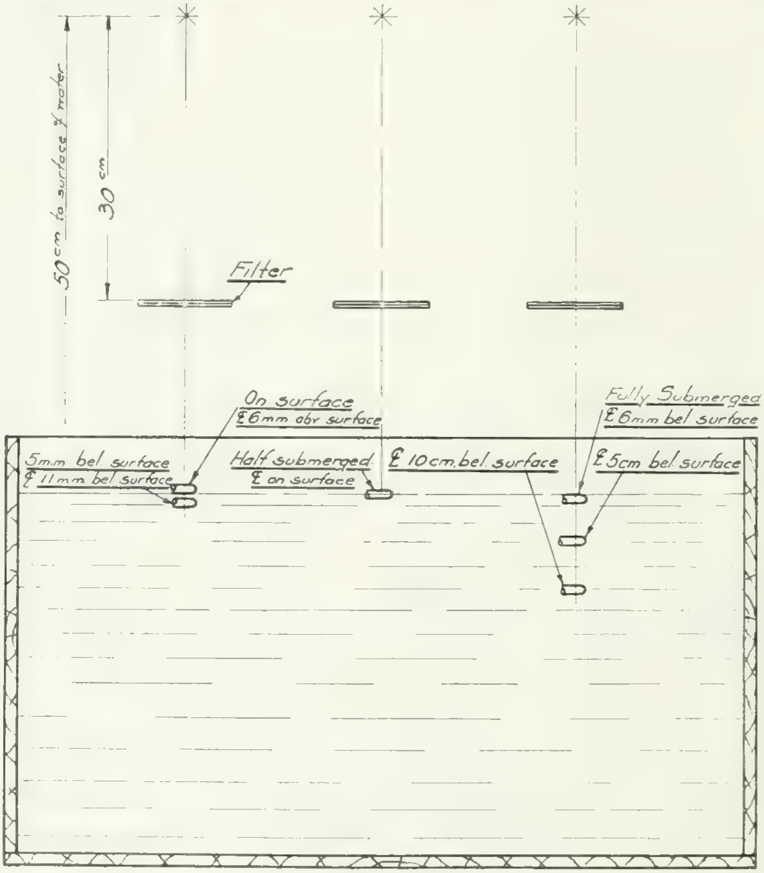


Fig. 3.

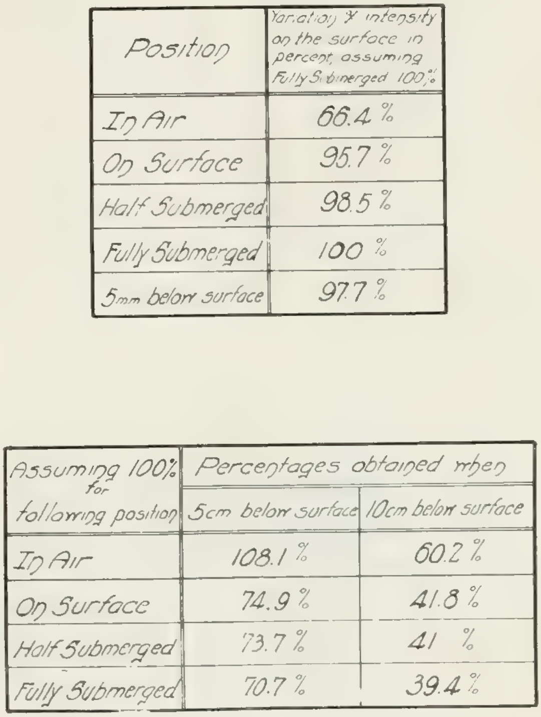
penetration experiments are reported without giving the exact position of the ionization chamber, both on the surface and at various depths in the water, it is impossible for any other experimenter to check the reported penetration percentages. The dimensions of the ionization chamber will also cause a variation and should be reported. If these data are not given, the value of a report is greatly reduced, and in fact the data might be misleading.

We have made some computations of ten series of measurements showing with the same data that four different values can be obtained for the percentages of *x*-rays reaching 5 cm. and 10 cm. below the surface of water (5 and 10 cm. referring to the distance from the surface of the water to the center line of the electrode inside the cap of the ionization chamber). In making these computations, we have considered the incident radiation measured in air, on the surface, half submerged and fully submerged each as 100 per cent and then computed a corresponding percentage of intensity at 5 and 10 cm. below the surface for each of the positions considered as 100 per cent. The following table, shown by Figure 4, gives the results:

Assuming 100 Per Cent for the Following Positions	Percentages Obtained when	
	5 Cm. Below Surface, Per Cent	10 Cm. Below Surface, Per Cent
In air	108.1	60.2
On surface	74.9	41.8
Half submerged	73.7	41.0
Fully submerged	70.7	39.4

There are enough variable factors in deep *x*-ray therapy which will remain more or less variable, but here are variables which can be standardized. Recently, in conversation with Professor Russ, Physicist to the Middlesex Hospital, London, he expressed himself as being in favor of some set of standards of intensity being established. If standards are established and we all cooperate, penetration percentages are going to agree more nearly and we are all going to be able to understand each other. Such an outline of standards might be as follows:

1. The quality and dimensions of the ionization chamber.
2. The phantom to represent the tissue.
3. The exact position of the ionization chamber on the surface of the phantom in determining the 100 per cent intensity measurements.
4. The exact position of the ionization chamber in a phantom when making depth measurements, that is, whether the measurements refer to the surface, or center line of the ionization chamber.



Position	Variation of intensity on the surface in percent, assuming Fully Submerged 100%
In Air	66.4 %
On Surface	95.7 %
Half Submerged	98.5 %
Fully Submerged	100 %
5mm below surface	97.7 %

Assuming 100% for following position	Percentages obtained when	
	5cm below surface	10cm below surface
In Air	108.1 %	60.2 %
On Surface	74.9 %	41.8 %
Half Submerged	73.7 %	41 %
Fully Submerged	70.7 %	39.4 %

Fig. 4.

About fifteen years ago, the Illuminating Engineers of America were in about the same position as the roentgenologists are to-day. Their standards of measurements were somewhat similar from one industrial firm to another, but there was just enough difference between the standards used by each to make a serious difficulty in understanding each other. About 1910, the Illuminating Engineers met and drew up a set of standards. There soon followed what is called Mazda Service, an organization for keeping each firm in touch with various improvements from one factory to another, providing of course the firm happened to be a member of this organization. There has grown out of this close cooperation, increased business, more efficiency and better lamps.

Summing up the points that we have tried to bring out:

1. It has been shown experimentally that there is an increase in incident ray intensity as falling upon the surface of water over the incident ray measured in air, of 33.6 per cent, when measured with the ionization chamber just under the surface of the water. This increase in intensity must be taken into consideration in representing surface intensity, or intensity of *x*-rays producing an erythema.
2. It is shown experimentally that there is a variation of intensity measurements as recorded by an ionization chamber going from the surface of a phantom of water to fully submerged.
3. It has been shown experimentally that due to the variations of the surface intensity, there is a variation in penetration percentages.
4. These variations in penetration percentages can be overcome by the adoption of standards governing the quality, size and position of the ionization chamber in making measurements in a standard phantom.

DISCUSSION

MR. FAILLA. Mr. Weatherwax has just shown you that variations of several per cent occur in the results of ionization measurements by the mere choice of one position or another for the ionization chamber, to represent the skin dose in a water phantom. Which position should be taken to approximate as closely as possible the radiation which is effective in producing an erythema depends more or less on the personal opinion and judgment of the experimenter. Differences arising from this source, however, are small and practically negligible in comparison to errors which may be present.

The problem of ionization measurements in radiotherapy may be divided into two parts: (1) One in which the object is to obtain data regarding the amount of radiation reaching different tissue depths under various conditions of treatment. (2) One in which the object is to make sure that the dose which has been decided upon is actually administered to the patient. I am of the opinion that, for the present at least, it is inadvisable for the radiologist to attempt to make his own dosage charts. It is best for him to take the data which has been published by different investigators and work out *average* dosage charts for the conditions which apply as nearly as possible to his machine. In regard to part 2 of the problem, for dosage purposes, I think some form of iontoquantimeter should be used in addition to the instruments now in use (milliammeter, spark gap, etc.). For this purpose, however, I think it is preferable to use a fairly large ionization chamber which can be attached to the tube holder and does not require a very sensitive measuring instrument. I have made an ionization chamber 8 × 10 × 2 in., which fits into the filter holder of the *x*-ray machine, and even with a copper filter produces a current sufficiently large to be measured by an ordinary galvanometer. Dr. Duane used a similar device some years ago, but the galvanometer was of a high sensitivity type which requires very much more care than the one I am using now. This point is of considerable importance if the instrument is to be used in a doctor's office instead of in a physical laboratory.

PROF. DUANE. I was very much interested in Dr. Weatherwax's estimate of depth dose (at a distance of 10 cm. below the surface) of something like 41 per cent. I would like to know how large the field was, and also if the natural leak of the instrument was determined with the *x*-ray tube running. If not running, the natural leak measurement is of very little importance. The natural leak must be taken with the tube running and something to cover the chamber so as not to get the direct rays from the tube.

There is no question about the advantage of a small ionization chamber for *certain* purposes. Friedrich's chamber is superior to my own on that account for certain experiments.

In regard to the use of carbon: Nine years ago I was using carbon plates for reducing secondary radiation. In regard to the question of direction of the rays passing through the chamber, the effects are, as you know, in the case of Friedrich's chamber pretty much the same whether the rays go through the side or end. As to just what the effect would be, if the rays came from the end where the large cable is attached to the chamber, I am not quite clear. I have, of course, made a number of experiments with my own ionization chambers with the rays going through in different directions. Whether they produce greater or less current depends upon the thickness of the plates, the size, the shape, etc.

We are all very much pleased to have men from other countries come here and talk to us and give us the results of their measurements along the lines we are following here.

Dr. Weatherwax (closing discussion). In answer to the question Dr. Duane has asked as to the measurement of leakage while the tube was running—this was not done. I do not feel that this would change the results very much, because the field that we could possibly get from above was only 16 cm. in diameter; that was the largest possible field we could get, and it certainly would not make any difference in the changes that we got on the surface of the water. It might make a difference in the depth. This point is to be tested and reported on later.

DISCUSSION ON PAPER BY PROF. WILLIAM DUANE ON MEASUREMENT OF DOSAGE BY MEANS OF IONIZATION CHAMBERS*

Dr. Glasser. I thank you very much for your kind invitation to speak before the Society here, and especially for the honor of opening the discussion on the paper of one of the foremost physicists in the *x*-ray field, Prof. Duane. It is only the fact that I was active for nearly six years in the field of both practical and absolute dosage of the shorter wave-length rays while assistant to Professors Friedrich and Dessauer, which made it possible for me to accept your invitation. My six months' stay in this country and my duties in the Howard A. Kelly Hospital in Baltimore, as well as the kindness of all the physicians in the hospitals and factories which I visited, have enabled me to become fairly well acquainted with the state of affairs in this field in America. I would like to take this opportunity to thank all those men for their kindness.

From the presentation of Prof. Duane's excellent paper you have already become acquainted with the fundamental principles of his method of measuring the quality and quantity of *x*-rays. I should like to answer briefly some questions with regard to the difference between the Duane measuring arrangement and the Friedrich iontoquantimeter. I hope that the two drawings in Figure 1 will make clear my meaning.

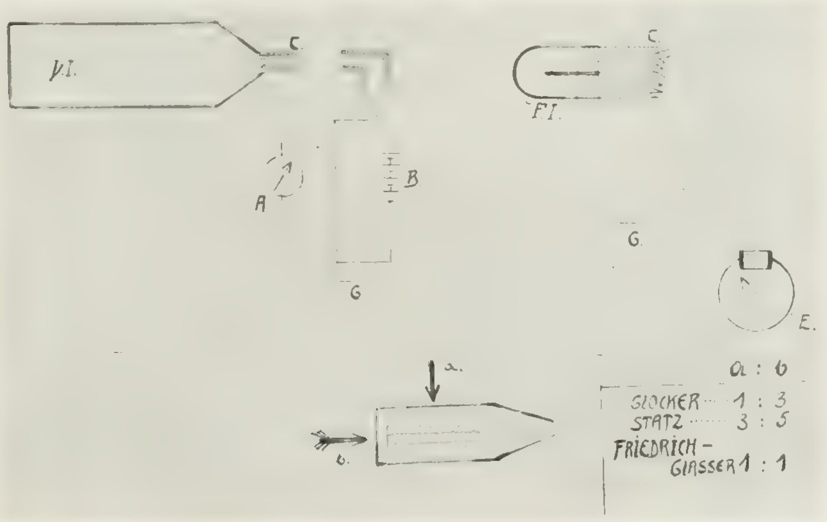


Fig. 1.

Duane measures the current passing between aluminum electrodes in the ionization chamber DI. This current is sent through by the battery B and its strength depends on the ionization in the chamber. The measuring instrument A is similar to a milliammeter, except that its sensitivity is about 100,000 times as great. The galvanometer circuit is completed when radiation enters the ionization chamber and then a steady deflection of the calibrated galvanometer is produced. The magnitude of the deflection, together with the time of exposure to the rays gives a measure of the dose. The advantages of the method are: (1) The arrangement is very sensitive, (2) it gives a steady deflection of the galvanometer pointer and therefore is easy of observation. Both surface and depth dose can be measured under fixed conditions, the latter only in a water phantom. The disadvantages are: (1) The use of a relatively large ionization chamber (I shall come back later to the difficulty of measuring accurately with it), (2) it is very difficult for the practical man to make proper use of the extremely sensitive galvanometer (this is borne out by the experiences of which Dr. Pfahler spoke at the Detroit meeting), (3) fluctuations in the line voltage and current cause variations in the intensity of the rays and therefore variations in the galvanometer reading; therefore the mean value of the deflection has to be taken for the calculation of the dose.

---

* This paper appeared in the May number of the Journal.

At the upper right-hand corner of Figure 1 you see the schematic representation of the Friedrich iontoquantimeter arrangement. FI is the little horn ionization chamber. It has approximately $1/10$ of the volume of the Duane ionization chamber. The inner electrode is connected with an electrometer which works just like an ordinary gold-leaf electroscope. This, together with the inner electrode, must be charged by means of a special charging device. On account of the ionization in the chamber the charge passes to the wall of the chamber, which is grounded; the potential of the electrometer goes back to zero. The time required for the pointer to go back gives a measure of the applied dose. The advantages of this method are: (1) The use of a very small ionization chamber which can even be introduced into body cavities. Thus the depth dose can be measured, not only in a water phantom, but in the body itself, during the treatment. (2) The less sensitive indicating instrument is much better for practical purposes; it automatically records variations in the intensity. A disadvantage is the longer time consumed to charge and read the instrument.

With regard to Prof. Duane's method I should like especially to mention the elegant manner of measuring the quality of the radiation by determining the "effective wavelength." This method is similar to the Dessauer method of measuring the absorption coefficient μ for water with the Bachem electroscope. However, Duane's method has the advantage that with the same ionization chamber he can also measure surface and depth doses. Of course these can also be measured with the Friedrich ionization chamber.

Coming to this method of measuring the intensity or quantity of the rays: In the different constructions of ionization chambers which I have made so far, I have always noticed that two things must be taken into consideration for measuring depth doses. The first of these is the question of the so-called "direction effect," which was first noticed by Glocker. Permit me to explain this statement by means of the diagram in the lower half of Figure 1. It shows a Duane ionization chamber. The rays falling perpendicularly on the chamber are denoted by *a*, those falling axially by *b*. It has now developed in most cases that radiation of a given strength falling on the chamber in the direction *b* produces a much greater current in the chamber than rays of the same strength incident in the direction *a*. (Exceptions are sphere ionization chambers.) A few comparative values are given: Glocker found for an ordinary chamber a ratio of the two measured intensities of 1:3, Statz, a ratio of 3:5 and Friedrich and Glasser, for their small horn ionization chamber, 1:1 (of course only in measuring such rays as do not run in the same direction as the feeding cable). In other words, there was no "direction effect." You will realize that it is a matter of great importance that the measuring chamber should be so constructed that radiation incident in any direction, e.g., in the case of the scattered radiation, shall produce equal ionization for equal intensity. In the case of the surface dose the main effect is produced by the primary rays, which are undirectional. In the case of the depth dose the main effect is produced by the scattered rays, which come from all directions. If the ionization chamber shows the "direction effect" the depth dose in percentage of the surface dose will undoubtedly be measured inaccurately. Standardizing of such small ionization chambers by comparison with very large chambers, which can be built without "direction effect," takes this effect of the small chamber into account only if the position of the small chamber in the body, phantom, etc., is always exactly indicated.

The second demand which is made of a chamber measuring ionization is that it have the smallest possible volume. This point was first emphasized by Dessauer, who showed that the introduction of a relatively large extraneous object into the body causes radical changes in the conditions of scattering and thus makes impossible a correct determination of the true depth dose. Figure 2 shows the results of measurements which I made some years ago in order to determine what influence air included in the body (e.g., in the case of the lungs) has upon the depth dose. An air volume V, of about twice the size of the Duane chamber, was placed at different points in the water phantom W, and under the same conditions of radiation in each case the depth dose under the phantom was measured with a Friedrich ionization chamber, as shown. Below are shown the relative values of these depth doses. You can readily see what a great influence the position of the air volume has upon the depth dose solely through a change in the scattering conditions, for the radiation passes always through the same layer of water. It would be interesting to know whether such differences of scattering distribution occur in using Prof. Duane's chamber. Certainly, on account of the presence of the various layers of aluminum and on account of the smaller air volume, the effect will be much smaller; nevertheless it seems to me that the small depth dose of 33 per cent under normal conditions, which Pfahler measured with the Duane chamber, as he mentioned in Detroit, can be traced to the fact that this chamber did not measure the real amount of scattered radiation.

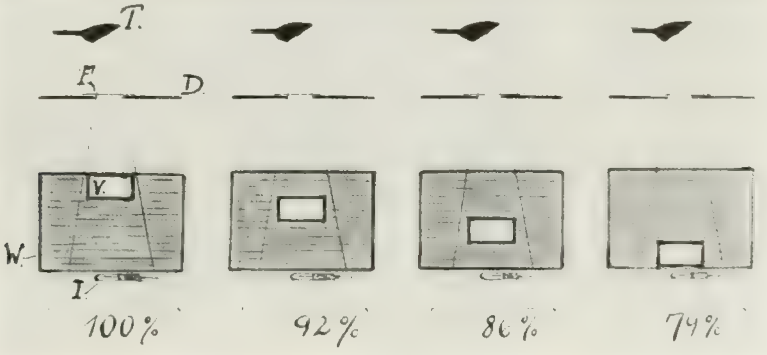


Fig. 2.

The third point I want to mention is that all the measurements with the Duane arrangement involve a fixed technique, with regard to effective wave-length, focus skin distance, size of field, etc. Friedrich wants to avoid this, and he has succeeded in doing so with the horn chamber. I am sorry that I can not go more into detail on these points. The horn chamber measures the intensity practically independent of the hardness of rays now in use. Experiments which we have made at the Howard A. Kelly hospital have shown that this independence of dose and wave-length is valid even down to the γ-rays of radium. It must be said, however, that as rays of different hardness can produce different biological effects, it remains necessary to measure the quality of the radiation. But, necessary as this specification of hardness may be, it involves great difficulties, partly of a technical nature and partly due to phenomena which science as yet is not able fully to explain. I will only mention that, according to recent investigations by Compton and Crowther, it must be suspected that the scattered rays may have a different quality from that of the primary radiation. You can see what a great influence this would have on the measurement of the dose. Certainly in this case, as in the case of many practical questions, that ionization chamber which measures the dose correctly independent of all these factors, would be given the preference.

All in all, it seems to me that a very small horn ionization chamber has many advantages over a larger one of any other material. It serves the purpose of the physician better, in that he can introduce it even into body cavities and watch the indicating instrument during the whole treatment; the physicist will give the horn chamber the preference for the reasons enumerated above. Moreover, any small chamber, as well as a larger one, can be standardized by means of a very large one, as Duane, Holthusen, Friedrich and Glasser have shown. I have a paper in the January number of your Journal in which such standardizing experiments with a very large ionization chamber are described in great detail.

A few words as to the measuring instrument: With the small horn chamber an electroscope must be used, for even the most sensitive galvanometer would here detect practically no current. Nevertheless modern science has made it possible to measure the current of a small horn ionization chamber, and that not with a delicate highly sensitive galvanometer, but with an ordinary instrument only a little more sensitive than a milliammeter. You all know from your radio sets the amplifying tubes which are used to magnify the small currents received by the antennæ. The same thing is possible in the case of the small current in the ionization chamber; and arrangements embodying this principle have already been employed in Europe. I would like to call your attention to such an arrangement in Figure 3, which is manufactured by the firm of Siemens and Halske. The ionization current of the small Friedrich chamber K is magnified approximately 100,000 times by the amplifier tube V, and can not only be measured by an ordinary measuring instrument, but even recorded in a diagram for the whole treatment. You will easily see the ideal combination of the small chamber and good galvanometer for practical purposes in connection with the factors I mentioned above. Since almost everyone has a radio set nowadays the use of this instrument should not be too difficult. I should like to say a few words on the biological standardization of dosage-measuring instruments in terms of electrical units. Duane's galvanometer scale is calibrated for a certain ionization chamber in terms of a certain unit, which he calls E. If he multiplies this number E by the time of exposure, he gets the applied dose in another unit *e*, that is, in the unit in which Friedrich first calibrated his iontoquantimeter seven years ago. Again I regret that I cannot go more into detail on this point. According to Prof. Duane's observations, his number *e* does not agree with Friedrich's for a given dose. His value is always much larger than Friedrich's. This fact was mentioned by Friedrich and Glasser in a short communication at the Berlin Roentgen Ray meeting in 1920. It may be mentioned here that the difference is given through the definition by both investigators. In determining dosages Friedrich measures with his ionization chamber the energy absorbed in the tissues. Duane, on the other hand, measures the energy of the original *x*-ray bundle by the absorbtion in air. The fact was also discussed at length in the paper in the January number of your Journal, of which I spoke before. Friedrich will, in the near future, publish the quantitative results. This, however, has no bearing on the practical application of the iontoquantimeter in its present form, since a definite dose corresponds to a definite number of divisions on the scale.

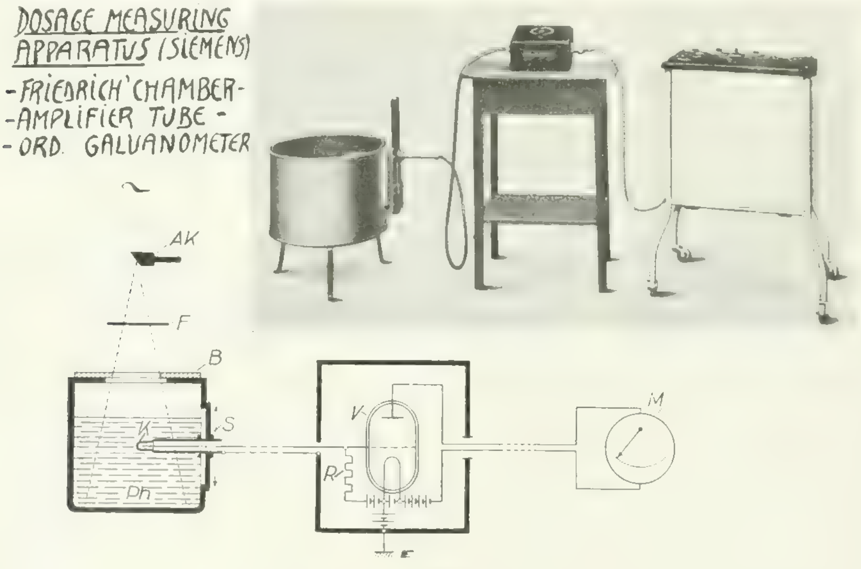


Fig. 3.

In conclusion, permit me to say a few words as to the attitude of the physicist toward these dosage problems. We have divided up the whole problem of dosage into two parts: practical and absolute dosage. The substance of Prof. Duane's paper and of my own words up to this point belongs mostly to the field of practical dosage, that is, methods are given for measuring the quality and quantity of the rays at every point of the radiated body. But do not get the idea which I have frequently heard expressed on both sides of the Atlantic that the physicist is the man of large doses which he wants to apply all at once, the man of large sizes of field, focus skin distance, etc. In other words, a man who recommends applying the physical dose without taking into account the biological, anatomical and physiological considerations which play an important part in the determination of the correct dose. It is for this latter reason that the expression of absolute dose was introduced and emphasized, since it is absolutely necessary to arrive at a closer approximation to the actual biological ray effect by means of an instrument measuring this effect that is the absolute dose. It is in this field that the physicists have given us a series of valuable researches. I have recently described some of these which were carried out with the aid of the small ionization chamber. These, as well as a whole series of other biological experiments, show how much the small horn ionization chamber is to be preferred, especially in these absolute dosage measurements.

No one will deny the fact that the ultimate purpose of our dosage determinations is a biological one. But so long as biology cannot formulate its requirements exactly (and that will be the case as long as we have only such incomplete data) the best thing we can do is to measure as accurately as possible everything that can be measured; and that is the physical part of the dose. As soon as we know more on the biological side of these questions we can, if necessary, modify the physical dose.

At present the main problem for the investigator is to collect and systematize our present knowledge of the biological phenomena involved. With this as a starting point, using the tools which physics, chemistry and biology have given him, he must work toward the solution of the problem of the biological effect of roentgen radiation. If I were to look into the future from the physical standpoint, and guess at the solution of this problem, I would say that this solution will perhaps be found in the use, not of a single practical wave-length of a certain roentgen-ray bundle, but in the use of all combinations of all wave-lengths, from the longest electric waves through heat waves, light waves, roentgen waves, down to the shortest rays of radium. I am sure that in this field also the medical man must work hand in hand with the physicist, to their mutual advantage.

STEREOSCOPY OF THE ACCESSORY SINUSES*

BY G. W. GRIER, M.D.

PITTSBURGH, PENNSYLVANIA

WHILE the value of stereoscopy in sinus work is admitted by the majority of roentgenologists, I have gained the impression from visits to my friends in various parts of the country, that it is often not a routine procedure in their laboratories. Presumably, this failure to use in practice a procedure which is theoretically desirable must arise from one of two reasons: First, there is doubt as to whether its use is of real advantage; second, it is too much trouble to be bothered with as a routine method.

It is not possible for me to prove in a short paper like this the practical advantages of this method. As a matter of fact, the only way one can be convinced is to try it as a routine measure for a short period. The additional information thus obtained will be so evident that one will never be satisfied with anything else. This subject was discussed in detail by Van Zwaluwenburg in his masterly article delivered before this Society at the annual meeting in Washington in September, 1921. I can only add that I have found the method of inestimable value in a large number of cases, and that the additional information obtained and the feeling of certainty as to the conditions present are ample compensation for any extra trouble.

My object in this paper is to remind you again of the value of stereoscopy in sinus work and to demonstrate a method of making plates that always stereoscope, a method which is no more trouble to carry out than the making of flat plates. The plates so made can be viewed singly and are made in what are recognized as standard positions. The tube is shifted vertically as recommended by Van Zwaluwenburg. The angles, however, are a little different and are accurately measured.

I use the head-rest which I described before this Society at the midwinter meeting two years ago, although this is not essential to stereoscopy. The average time consumed in fitting the patient's head in the head-rest and making two sets of stereoscopic plates is three minutes. This is certainly not a time-consuming procedure.

---

*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

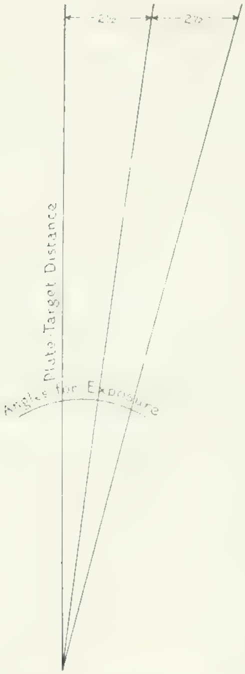


FIG. 1. Method of determining the proper angles for the different exposures.

The position which the tube shall occupy for the different exposures is determined by laying out the angles on a sheet of paper and then transferring them to a triangular sheet of aluminum with which the actual measuring on the patient is done. Since there is but comparatively little difference in the size of heads, it is practical to make sinus exposures with a fixed distance between the tube target and the plate. The procedure is easier if a small cone is used on the tube stand and the end of the cone brought a short distance from the back of the patient's head. With the tube in this position, the distance from the target to the plate is measured and this distance is used as the altitude in drawing a triangle, base up, which is to determine our angles. The base of this triangle is twice the distance between the pupils of the eyes, or 5 in. The triangle so constructed is halved by bisecting the base line. We now have the three angles at which to make our exposures, represented by the sides of the two triangles, and as the middle angle is the stereoscopic distance, or 2½ in. from either end, it will stereoscope with either.

This triangle is drawn full size on a piece of paper and the resulting angles are copied on an aluminum triangle which is fixed to the head-rest or which may be used by placing it against the side of the patient's head in the usual way. One side of the aluminum triangle is so placed as to connect the external auditory meatus and the external canthus, the point of the triangle at the canthus, the base of the triangle extending toward the forehead. The altitude of this triangle then roughly outlines the base of the skull. The first exposure, or the one made at the greatest angle, is made at an angle of 30° to the base line. This is easily done by tilting the tube so that a line drawn down lengthwise through the middle of the cone would be continuous with the line drawn on the aluminum triangle. The two succeeding exposures are made at the remaining angles in a similar manner.

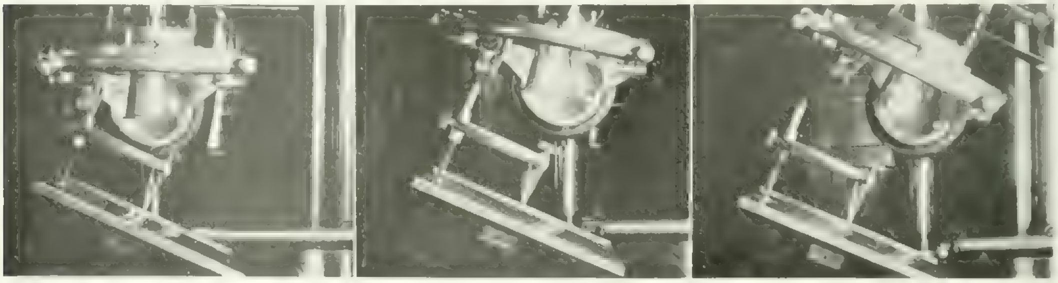


FIG. 2. Tube tilted to the different positions for the three exposures.

We thus get three plates, any one of which is a perfectly good flat plate, the middle one stereoscoping with either one of the others, being the plate for the right eye with one and the plate for the left eye with the other. When viewed singly, the plate made at 30° shows the frontals best, and the last one shows the maxillaries best. The middle one is made at about 25° which is the universally accepted angle.

Since talking with Dr. Granger of New Orleans about his sphenoid work, I have recently added a fourth exposure made lower down, which, when stereoscoped with the third one, shows the sphenoids very nicely. I have not had time yet to draw any conclusions regarding the value of this.

In conclusion: I am sure anyone who will take the trouble to stereoscope all his sinus cases in this way, for a short time, and study the plates carefully, will quickly convince himself that the method yields information not to be had in any other way.

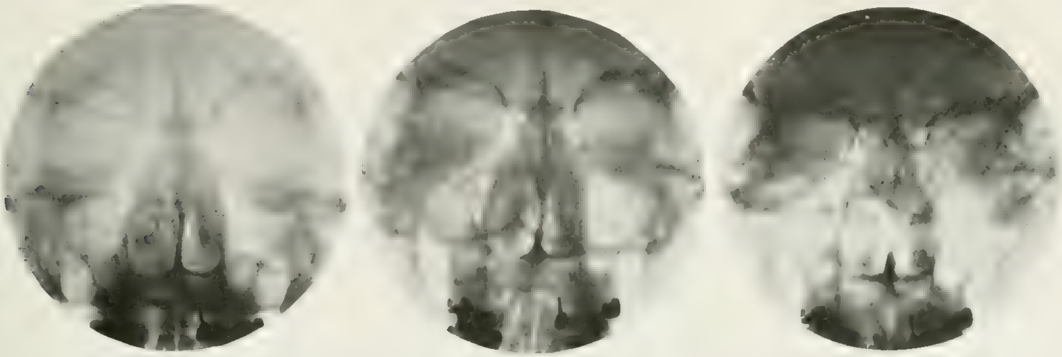


Fig. 3. The resulting views from the three exposures, the middle one of which stereoscopes with either of the other two.

DISCUSSION

Dr. Law. I am glad Dr. Grier spoke of stereoscopy of the sinuses. A few years ago I used to think that it was not necessary, but in those days we were looking for gross lesions and for opacity in the sinuses.

Since the war I have given up that idea. Any case which will show opaque sinuses is fairly readily diagnosed by the surgeon before the patient comes to you, and any one can tell the difference between an opaque sinus and one which is clear. That is not the type of case that the surgeon wants the most information from. What he wants is the case that comes in with vague symptoms—headaches, postnasal discharge and some focal infection—cases in which he cannot see pus on physical examination. That is the type of case that requires carefully made stereoscopic plates. When I say "carefully made" I do not mean carefully made stereoscopically, because that is very easy as far as the angle is concerned. When I say "perfect plates" I mean technically perfect so far as detail is concerned. You need a plate in which the bony outlines of the walls of the sinuses, the ethmoid septa particularly, are clean cut, in which there has been no motion to the patient, no movement or tremble from respiratory action, and no blurring from the target of the tube

This presentation of Dr. Grier is very clever. It is well worth doing, and the effort does not require any more time than making ordinary plates. Moreover, if one has the angle permanently fixed on the tube stand, it does save trouble. I congratulate Dr. Grier on his cleverness; but he did not say anything about the real value of what he has presented.

Chronic sinusitis is really what we are trying to diagnose, and you get that only by the change in the bony structures. You put a plate in the box, look at it, and to all intents and purposes that plate is perfectly normal. The frontal sinus shows well, the ethmoid region is nice and black, apparently clean-cut and clear—a perfectly normal sinus. The same way with the antrum; but there are the indirect evidences. If you get the symptoms you find that the patient has probably a postnasal discharge, periodic headache coming on at a certain time during the day and disappearing the same way; perhaps you get some little eye trouble. Interpretation of the plates a year or so ago would have been perfectly clear sinuses, but now the signs we look for are the bony changes. Learn to study the ethmoid region. That is just as important as the mastoid region; it is the same structure and goes through the same changes. If the mastoid had as good drainage as the ethmoid, you would not get operative mastoids as you do now. Notice the walls—whether they are absorbed or whether they are thinned out, thickened or fuzzy, and learn the appearance of those changes in chronic conditions; and you will deliver to the surgeon a diagnosis on which he can base his method of treatment and thereby help your patient.

Dr. Grier (closing discussion). It does not matter in what position you put the head in making these examinations, because you are measuring from the base line of the skull, and if you measure the angles at which you work the position of the head is of no importance.

I have purposely omitted saying anything about what we learn in these stereoscopic examinations of the sinuses for two reasons. The first is that it opens up a subject which I feel is too large to be discussed in this short paper. The second reason is that I have seen so many things since making these examinations which I do not understand. Shadows appear which I never saw before and which I am unable to interpret. It occurred to me, however, that while I was working on the question of interpretation I would report this technique, in order, if possible, to stimulate interest in this method of examination.

On account of a defect in my vision I have a great deal of difficulty in seeing stereoscopically, and unless the plates are perfectly made they will not stereoscope for me. I do not make lateral plates, because the only thing I learn from the lateral projection is the depth of the sinuses and this is not improved by the stereoscopic vision, whereas the frontal projections demonstrate the pathology present.

TRANSLATIONS AND ABSTRACTS

Hütten, V. D. Duration of cure of operated breast carcinoma with and without prophylactic *x*-ray treatment. *München. med. Wchnschr.*, 1922,i, 13.

The classification was made according to Steinthal-Anschütz, based upon the severity of the lesion in Groups I, II and III. Each group was subdivided into: A, those who had not been treated; B, those who had been treated moderately; and C, those who had received intensive irradiation. The following results are reported:

Group I

A. 23 cases.

After three years, living, free from recurrence, of 19 cases, 19 (100 per cent).

After five years, living, free from recurrence, of 12 cases, 12 (100 per cent).

After ten years, living, free from recurrence, of 5 cases, 4 (80 per cent).

B. 3 cases.

After three years, living, free from recurrence, of 3 cases, 3 (100 per cent).

After five years, living, free from recurrence, of 2 cases, 2 (100 per cent).

C. 6 cases.

Term of observation too short for adequate observation.

Group II

A. 39 cases.

After three years, living, free from recurrence, of 35 patients, 3 (8.6 per cent).

After five years, living, free from recurrence, of 23 patients, 2 (8.7 per cent).

After ten years, living, free from recurrence, of 5 patients, 0 (0 per cent).

B. 4 cases.

After three years, living, free from recurrence, of 3 patients, 0 (0 per cent).

After five years, living, free from recurrence, of 1 patient, 0 (0 per cent).

C. 2 cases.

After one-half year, 2 recurrences.

Group III

A. 70 cases.

After three years, living, free from recurrence, of 63 patients, 31 (49. 2 per cent).

After five years, living, free from recurrence, of 46 patients, 18 (39.1 per cent).

After ten years, living, free from recurrence, of 21 patients, 4 (19.1 per cent).

B. 8 cases.

After three years, living, free from recurrence, of 7 patients, 1 (14.3 per cent).

After five years, living, free from recurrence, of 1 patient, 0 (0 per cent).

C. 4 cases.

Recurrence in one year 2 patients: 1 living and well one year after operation, 1 living and well two years after operation.

The author on the basis of the material of the Giessen Klinik takes a similar point of view as that of the clinics of Tubingen and Leipsic that through the after-treatment with *x*-ray the result is made worse.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

CORRESPONDENCE

To The Editor:

In his very interesting and valuable article* entitled "A Biological Coefficient for the Aluminum Filter," Dr. Francis B. Sheldon proposes a law, or formula, by which the time required for an erythema dose of x-rays filtered through aluminum can be computed from the known values of the tube current, the spark-gap, the target-skin distance, and the thickness of the filter. This equation, which he has found to fit fairly satisfactorily both his observations and those of others for filters ranging from one to 10 mm. in thickness, can be put in the condensed form

$$mam \times G^2/D^2 = t(15 + t/2)$$

where *mam* is the number of milliampere-minutes, G^2 is the square of the spark-gap in inches, D^2 is the square of the target-skin distance in inches, t is the thickness of the filter in millimeters, and the line / denotes division. For simplicity in writing and printing, we shall hereafter denote the entire expression on the left of the equality sign by the single letter R. It is a measure of the total amount of radiation that would reach the skin if the filter were absent. The equation then becomes $R = t(15 + t/2)$. It is evident that this equation cannot be strictly correct, because it requires R to be zero when t is zero. This means that when there is no filter, an erythema can be produced without any radiation at all, an evidently preposterous claim. In fact, we know that when there is no filter, the value of R for an erythema is something like 4 or 5. This discrepancy can be easily removed by adding another term to the right side of the equation. This quantity, which we may denote by E_0, is equal to the value of R that produces an erythema when there is no filter; the equation then becomes $R = E_0 + t(a + bt)$, where a and b are quantities corresponding to the 15 and the $1/2$ in Dr. Sheldon's equation, but differing from these in actual values. The equation we have just written is evidently equivalent to $R - E_0 = t(a + bt)$, which shows that it is not R, but the excess of R over E_0 that is determined by the thickness of the filter. This is obviously as it should be; the thickness of the filter does not determine the amount of radiation required for an erythema, but only the *additional* radiation above what is needed when there is no filter; $t(a + bt)$ is the amount, erythemally considered, by which the filter reduces the radiation.

Table I

5 MA. 9-IN. GAP, 10-IN. DISTANCE

Filter, Mm.	Time	
	Original, Min.	Modified, Min.
0.5	1.88	2.81
1.0	3.7	4.5
2.0	7.9	8.1
3.0	12.2	12.1
4.0	16.8	16.5
5.0	21.6	21.3
6.0	26.7	26.4
7.0	32.1	31.8
10.0	49.4	50.5

If, for the purpose of illustration, we assume that E_0 is exactly 5, the data given by Dr. Sheldon on page 307 lead to the equation $R = 5 + t(13.5 + 0.75t)$; by means of this modified equation the times are given in the third column of table I have computed. Excepting the two thinnest filters these differ but little from those found by means of Dr. Sheldon's original equation (column 2).

---

* Am. J. Roentgenol., Apr., 1923, x, 307.

For the thinnest filters, Dr. Sheldon's formula leads to lower values; the thinner the filter, the greater the difference between the times as computed by the two formulas. That his formula probably gives times that are too low, when the filter is thin, is indicated by his recorded observations; under experiment Number 3, filter 1 mm., it is stated that the computed time gave only a slight reddening that quickly disappeared; under Number 5, filter 1 mm., we are told that for a dose nearly double (actually 1.82) that computed for an erythema there was only a reddening that lasted for six months. From the third column of Table 1, it appears that the dose for erythema is probably 20 per cent greater than that given in Experiment 3, and that the dose given in Experiment 5 was only 50 per cent greater than that required for erythema.

It should be remembered that the values computed here by means of the modified formula are merely illustrative and are based upon an assumed erythema dose of unfiltered radiation that has been only guessed at. In all such work as that of Dr. Sheldon's the erythema dose of unfiltered radiation should be determined under the same conditions as are those with filters. As it is to be expected that the effect of the filter and also that the erythema dose without filter will depend upon the hardness of the radiation, observations should be grouped according to spark-gap, and those corresponding to the several spark-gaps should be separately studied. The various groups of values thus found for the constants E_0, a and b will yield very valuable information that may be amenable to simple explanation and formulation. It may be found that terms in higher powers of t will be required under some conditions in order to express the observations satisfactorily.

As Dr. Sheldon points out, the constants found by one observer may not satisfactorily fit the working conditions of another, on account of differences in the manner of measuring the spark-gap, errors in the measurement of the current, etc. This, however, does not greatly reduce the value of the compilation of such data, as the degree of concordance, or of disagreement, that is thus revealed will give valuable and much-needed information regarding the concordance that actually exists between the practices of different radiologists. Moreover, certain types of individual idiosyncrasies in the values of a and of b may be eliminated by dividing these quantities by the corresponding value of E_0.

I hope that Dr. Sheldon will make another study of the data he has in hand, taking into consideration the suggestions here made.

N. Ernest Dorsey.

Washington, D. C.,
May 7, 1923.

To The Editor:

First I wish to thank Dr. Dorsey for his very fair criticism of my Coefficient Formula. No doubt the formula would be better with a constant for the erythema dose included. However, the value of E_0, the erythema constant without a filter, is only 2 and not 4 or 5.

Taking the figures originally given by Witherbee and Remer for their unfiltered erythema dose, 3 ma., 3 in. spark-gap, 5 min. at 8 in. distance, we get a constant of 135/64 or approximately 2. I find that this works very well with my machine. Now in using this E_0, that is 2, the formula will have to be changed to make the time for the erythema, as found in the experiments, equal that given by using the original formula. To do this we would have to use a formula something like the following:

$$mam \times G^2/D^2 = 2 + t(12 + t)$$

t being the number of mm. of aluminum used for filter, and using $12 + t$ instead of $15 + t/2$ used in the original formula.

By using this formula the time obtained up to, and including, 7 mm. will be within a very few seconds of that found with the original formula, and above that the time will be slightly increased.

Francis B. Sheldon.

Fresno, Calif.,
May 25, 1923.

DR. GEORGE HONORED

At a meeting of the Royal Society of Medicine in London, on May 17, the Sir James MacKenzie Davidson memorial medal was awarded to Dr. Arial W. George of Boston.

This is the first time that this distinction has been awarded to an American. Dr. George has for many years been an exponent of roentgen-ray diagnosis of diseases of the gall-bladder, a theory which was for a long time rejected by many co-workers. The medal which was conferred upon him is a just recognition of this work.

The presiding officer was Sir Humphrey Rolleston, president of the Royal College of Physicians, and the meeting was attended by leading members of the British medical profession.

Dr. George's subject at this meeting was "The Pathological Gall-Bladder" and the occasion of the address was the annual memorial lecture, delivered this year in memory of Sir James MacKenzie Davidson, who was among the first *x*-ray martyrs. Dr. George was also a guest at the 150th annual dinner of the Medical Society of London.

PROFESSOR DUANE JOINS EDITORIAL STAFF

The Journal is very much pleased to announce that Prof. Duane has kindly consented to serve on its editorial staff. His work in the forefront of experimental radiology is well known and is recognized as having very materially assisted in placing American radiology on a stable and scientific basis. It is therefore a matter of congratulation to all of us that he has consented to give us more of his time and advice by serving in the capacity mentioned.

THE RADIOLOGICAL SOCIETY OF MEDICINE OF FRANCE

This Society announces the following board of officers for 1923:

President: Dr. Ledoux-Lebard, 22 Rue Clément-Marot, Paris.

Vice-Presidents: Dr. Barret, 33 Rue de Lisbonne, Paris; Dr. Castex, 13 Rue Kléber, Rennes.

Secretaries: Dr. Haret, 8 Rue Pierre-Haret, Paris; Dr. Dariaux, 9bis Boulevard Rochechouard, Paris; Dr. Nahen, 29 Rue de Sèvres, Paris.

Treasurer: Dr. Thoyer-Rozat, 12 Rue Desaix, Paris.

Committee on Publication: Dr. Aubourg, 9 Rue de Monceau, Paris; Dr. Belot, 36 Rue de Bellechasse, Paris; Dr. Ledoux-Lebard, 22 Rue Clément-Marot, Paris; Dr. Lenglet, 9 Rue Vezelay, Paris.

Editor: M. Masson, 120 Boulevard Saint-Germain, Paris.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page viii of this number of the JOURNAL. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (69 *East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Scott, S. Gilbert. A method for the opaque meal examination of the stomach. *Arch. Radiol. & Electroth.*, Mar., 1923, xxvii, 304.

The author reviews the current methods of examination and gives full details of the method which he employs. He incorrectly and doubtless inadvertently states that in America radioscopy was little used until recently. He decries the multiple plate method as impracticable and expensive for a busy hospital in England and states that its diagnostic value is not sufficient to justify the expense entailed. The combined screen and plate method is the generally approved one.

The author's method includes systematic screen palpation which must not be confused with the stomach prodding or palpation used by many workers. This palpation is carried out inch by inch, starting at the cardiac and ending at the duodenal end. Such a satisfactory screen examination requires attention to many small details which the author describes. Generally speaking he feels that it is unnecessary for the radiologist to know the clinical history of a gastric case. The author has found in many difficult cases, such as a small ulcer on the anterior or posterior wall of the stomach, or high up toward the cardiac end, extreme difficulty in demonstrating the condition on a plate or film, although the diagnosis was already definite from the screen study; and he goes so far as to state that any lesion demonstrated on a roentgenogram would easily be diagnosed by screen palpation, but that the reverse does not hold good. The two chief advantages of palpation under the screen are that after a time it can be carried out with rapidity; and that it is extremely necessary in the detection of small lesions. Errors in diagnosis, if traced to their source, are of extreme value. Every error in diagnosis should be thoroughly investigated. It is a mistake to slur over one's mistakes.

The author administers a vegetable purgative thirty-six to forty hours before the examination. He prefers castor oil. The last meal, which must consist of fluids, should not be taken less than an hour before the examination. The object of this preparation is to have the intestinal tract as empty as possible, while at the same time avoiding artificial conditions; that is to say, the effect of the aperient must have passed off. The patient should not feel unusually hungry, as this condition has a definite reflex effect on the behavior of the stomach.

The author employs a mixture of barium cream, commercially known as Ramul, made in three thicknesses: No. 1, thick, flavored, for esophageal cases; No. 2, medium thickness, flavored, for gastric cases; No. 3, thin, unflavored, for opaque enemata. These, being sterilized, keep for weeks, and therefore can be kept in stock. The barium itself is well held in suspension. The prescription is as follows:

No. 1. Thick flavored.		
Barium sulphate		10 oz.
Saccharin		2 gr.
Vanillin		5 gr.
Gum tragacanth		100 gr.
Distilled water	to	20 oz.
No. 2. Thin flavored.		
Barium sulphate		10 oz.
Saccharin		2 gr.
Vanillin		5 gr.
Gum tragacanth		60 gr.
Distilled water	to	20 oz.
No. 3. Thin unflavored.		
Barium sulphate		10 oz.
Gum tragacanth		60 gr.
Distilled water	to	20 oz.

The gum tragacanth and the barium sulphate should be mixed as powder, and the water added gradually. The whole is sterilized. It is better made up by a chemist, and a stock bottle can be kept for emergency. Being sterilized, it can be used for other purposes, such as injecting into sinuses or empyemas, using whichever thickness is most suitable for the case. This barium cream throws a very dense and homogeneous shadow, creeping readily into nooks and crevices, such as ulcer craters, appendices, etc.

No hard and fast rule is made as to amount of meal to be given in a given case; 3 to 4 oz. given at first, a further 6 oz. or more to be administered later as required.

Since pressure of work makes necessary the elimination of everything that does not prove to be of some diagnostic value, one of the first things investigated was whether the emptying time of the stomach gave any reliable information as to the state of the organ itself. The author can recall no case in which the emptying time of the stomach was of help in arriving at a diagnosis; the emptying time is influenced by so many unknown factors that he doubts its value. He claims that it is possible to obtain a difference of four hours in the emptying rate of the stomach in the same patient by starving or overfeeding him a day or two before the examination.

The author has also discarded the double meal method, as he has found that although in theory it should save time in actual practice, it may lead to serious diagnostic error. He therefore depends on the one meal, which he follows through into the intestines.

In order to carry out screen work expeditiously, every examination should develop a systematic routine. A systematic method should be employed in all fluoroscopic work. The presence of one lesion, a gastric ulcer, for instance, does not exclude the possibility of another lesion, a duodenal ulcer, for instance. The apparatus should be simplified. Protection should be hung around the apparatus rather than on the examiner. The protection should be ample.

Palpation is an important factor in this method. Some practice is necessary before the knack is acquired, and on it depends, to a great extent, the success of the method. It is necessary that the hands be trained to work in conjunction with each other, as each section of the stomach is examined in detail. Screen palpation should be done in both the horizontal and upright positions.

MacNeal, Ward, J., and Willis, George S. A skin cancer following exposure to radium. *J. Am. M. Assn.*, Feb. 17, 1923, lxxx, No. 7, p. 466.

The authors report in detail, with numerous photomicrographs, the case of a patient who worked with roentgen rays in his practice from 1905 to 1917; but not since then. Precautions for self-protection were carefully employed. From 1912 to June, 1920, he handled radium, without precautions for self-protection, in small amounts up to 1915, but in quite large amounts from 1915 to 1920 (from 200 to 365 mg. in individual tubes, taken between the right thumb and forefinger almost every day). Various changes, which may be ascribed to the exposure to radium, began to be observed late in 1918, and since early in 1920 the skin changes have required constant care. In September, 1922, a fissure on the ball of the right thumb manifested a peculiar and extremely painful alteration in character, and on excision in October, this lesion proved to be a squamous-cell carcinoma.

Lemere, H. B. Progressive osteomyelitis of the frontal bone. *J. Am. M. Assn.*, Mar. 3, 1923, lxxx, No. 9, p. 596.

The author discusses a very interesting case of diffuse osteomyelitis of the frontal bone, progressive in nature, ending in death, through infection of the frontal sinuses. A basal meningitis complicated the case. An excellent review of the literature on the subject to date then follows. The etiology of this disease is still mysterious and the mortality with or without extensive bone removal is exceedingly high. The author calls particular attention to the necessity of publishing the roentgenograms rather than a statement of the roentgen findings, in order to make it possible carefully to study the literature of the subject. Bacteriological reports should also be made, and where death results, careful necropsy findings. In 21 spontaneous cases gathered from the literature, there were 7 recoveries, while in 20 postoperative cases, there were no recoveries. In none of the literature is the importance of the roentgen ray observations on the osteomyelitis sufficiently emphasized. The author believes the treatment and operative work should be checked by roentgenograms taken at least once a week, and all bone showing any involvement should be carefully removed.

Renaud, Maurice. The administration of morphin to cancer cases. *Ass. franc. p. l'etude du cancer*, Mar. 19, 1923.

The author reviews the dangers and inconveniences of morphinization in the course of chronic affections and declares that in spite of the temporary and often illusory advantages, the administration of morphin brings to the cancer patient no real benefit. On the one hand, the painful paroxysms, for the relief of which morphin is the sovereign remedy, are relatively rare in the course of the majority of neoplasms; and the majority of symptoms which render the cancer patient's life miserable are not entirely ameliorated by stupefying medication. Cancerous morphin addicts are the ones who complain the most. On the other hand, morphin is not in any way capable of attenuating the mental distress of the patients who suspect or know they are hopelessly condemned. Far from giving mental relief, morphinization encourages and develops disquietude. The morphin addict never knows true rest. He is in the state of perpetual malaise. Morphinization which increases the torments and accentuates the mental distress of the cancer patient is therefore a dangerous last resort. The cancerous patient is a depressed neurasthenic who should be sustained, stimulated, and encouraged. Morphin is good for nothing until it becomes necessary to relieve his pain.

Schenck, W. E., and Goosmann, Charles. Melanotic sarcoma of eye. *Cincin. M. J.*, Mar., 1922, iii, 1.

The authors decry the reports of cured melanotic sarcoma of the eye after only two or three years with no recurrence after surgical treatment. Such reports lead us into a false position of security. In order to insure cures, the authors query, "Should we use *x*-ray or radium first and then operation, or should we depend upon the *x*-ray or radium treatment entirely?" They conclude that operation should precede treatment with irradiation; that the irradiation should be administered only by an expert; and that under no circumstances should the use of an artificial eye be permitted.

BUXTON, ST. J. D. The association of the surgeon and radiologist in bone grafting. *Arch. Radiol. & Electroth.*, Mar., 1923, xxvii, 289.

The author believes the assistance given to the surgeon by roentgenography in the diagnosis of fractures and diseases of bone is one of the outstanding features of the progress of science. Assistance of the *x*-ray workers is valuable in experimental work, especially on man in watching the progress of each case of bone graft. In studying the indications for bone grafting in a long bone the roentgenogram shows the condition of the bone and thus assists in making a choice of bone grafting in each type of case. The *x*-ray help is especially useful in the avoidance of failure to obtain union after operation by bone grafting. This failure may be due to the following causes:

1. Waking up of latent infection, and so causing suppuration in the wound.
2. Poorly nourished covering of the graft owing to deep scar and skin cicatrices.
3. Defective technique in application of the graft.
4. Fracture of the graft.

The value of roentgenography in watching the progress cannot be exaggerated. In the case that does well it is by the roentgenogram as much as by the apparent strength of the limb that we can judge for what period a splint should be worn.

A series of very interesting roentgenograms is appended to the article.

BOST, T. C. Calcification of the ovary. *J. Am. M. Assn.*, Mar. 31, 1923, lxxx, 912.

Moschcowitz in 1916 compiled 5 cases. Dicken has since added another case. The author's case herewith reported in detail brings the total to 7. The specimen measured about 5 by 3 cm., occupying the site of the ovary. Normal Fallopian tube was attached to the upper surface. The general shape of the mass was that of a flattened egg. The surface was smooth, mottled yellow; but the tissue was of uniform bony hardness. Diagnosis—calcification of the ovary.

ROBERTS, C. S. LANE. Some considerations of the sacroiliac joint. *Lancet*, Apr. 21, 1923, cciv, 787.

This is a well-prepared consideration of the morphology, gross anatomy, movements and the more common pathological conditions of relaxation and strain of the sacroiliac joint. Although no reference is made to the employment of the *x*-rays in the diagnosis of this condition, the facts presented should be of interest in the interpretation of the *x*-ray findings in this situation.

HODGES, FRED M. Subdiaphragmatic abscess. *J. Am. M. Assn.*, Apr. 14, 1923, lxxx, 1055.

This very interesting article is well worthy of detailed study by every reader of this journal. Early diagnosis and treatment usually lead to cure, while late diagnosis often means serious complications or death. A history of a recent abdominal operation or infection, followed by an unexplained elevation of the pulse and temperature, should require a careful elimination of subdiaphragmatic abscess. The roentgen ray is a very important diagnostic aid, and will almost invariably give valuable and definite information. In any acute upper abdominal infection, an elevated and rigid diaphragm should lead to the suspicion of subdiaphragmatic abscess. A diaphragm normal in position, contour and motility usually eliminates the possibility of an abscess just beneath. Promiscuous needling is never indicated, since in this way the pleural cavity may be unnecessarily infected.

FRIEDLAENDER, BERNHARD. Diagnostic value of artificial pneumoperitoneum in sterility in women. *J. Mich. M. Soc.*, Apr., 1923 xxi, 195.

The author concludes that in sterility of the woman we should undertake a routine and thorough examination of the organs of reproduction in the male as well as in the female and try to find the cause of sterility. The patency or non-patency of the Fallopian tubes can only be determined, without a surgical exploration, by the inflation with gas by the transuterine route. Pneumoperitoneum is free from danger if we are careful in the selection of cases. Roentgenograms of the pneumoperitoneum are valuable aids in demonstrating the condition of the uterus, tubes and ovaries, the presence of omental and bowel adhesions, pregnancy, etc. The use of carbon dioxide instead of oxygen diminishes the discomforts following the inflation and the patient is able to leave the office in thirty minutes.

THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. X JULY, 1923 No. 7

OBSERVATIONS ON OSTEITIS DEFORMANS

BY SHERWOOD MOORE, M.D.

From the X-Ray Laboratory of the Washington University School of Medicine

ST. LOUIS, MISSOURI

SINCE Paget's[1] original article on osteitis deformans appeared in 1877, the Index Medicus shows two hundred eighty-seven titles of articles dealing with that and related conditions. Despite this large amount of observation and study, the disease is still as obscure as to etiology and pathogenesis as it was in Paget's time. The fact that this obscurity exists seems to warrant report of the observations on 4 cases of unusual type along with a review of the literature. It is not proposed to go into a general discussion of all aspects of Paget's disease of bone, but to confine this paper to consideration of a limited number of its features. For additional information the reader is referred to Paget's publications and those of Gruner, Scrimger and Foster,[2] of Schirmer,[3] of Legros and Léri[4] and of Da Costa, Funk, Bergheim and Hawk.[5]

There are in the literature 213 cases of osteitis deformans, according to the figures of Leahy (1918)[6] to which number 33 subsequent ones can be added which do not include the writer's observation of 14 cases. These are chiefly from Europe and the United States. The disease has been reported from Australia[7, 8, 9, 10] and from Japan;[11] Hewitt[12] and Da Costa[13] have reported cases in negroes and the writer has witnessed an autopsy on an advanced case in a negress (unreported). Recently an article[14] has appeared describing the disease in three monkeys which was proved to be diagnostically correct from both the clinical and pathological points of view. The reports indicate a greater incidence in England and France than elsewhere in Europe, but it seems that this is due to the fact that greater attention has been given the disease in those countries. In the United States reports began to appear about the year 1890 and have been increasingly noted since. They are from all parts of the country. Clopton,[15] Hewitt[12] Deppe[16] and L. H. Hemplemann[17] have reported a total of 6 cases from St. Louis. The disease is commonly considered to be rare, but the facts hardly warrant this belief. Paget[18] at the time of his second communication had seen 23 cases and Locke[19] states that he has seen 50. There have been in the Washington University x-ray department 3 instances in 19,000 successive admissions; but the total of 14 cases in 163,148 admissions to both the Barnes Hospital and the Washington University Dispensary on the whole confirms the average of the incidences reported by Carman and Carrick[20] quoting statistics from the New Jefferson Hospital and the Johns Hopkins Hospital, also by LeWald (unpublished) of one in 11,000 admissions.

Osteitis deformans can be defined as a general disease of the skeleton, probably due to a constitutional state, as first suggested by Thibierge,[21] the chief manifestations of which are bony enlargement and subsequent deformity. The tendency of the disease is toward a slow, gradual involvement of the entire skeleton, although it may remain confined to a single bone or portion thereof for an extended period. Many writers have described a mono-osteitic type of the disease, but it must be said that such cases were not under sufficiently prolonged observation to establish firmly the existence of such a type.

As to its symptoms, reports of the disease in the literature have an impressive similarity to one another and to Paget's account. In fact, after reading a series of clinical descriptions it would almost seem as if they might be interchangeable; which might also be said of the illustrations which accompany them. When fully developed the disease can be diagnosed at a glance, although it is well to bear in mind that senile and arthritic changes of the skeleton can closely simulate the deformity and carriage of Paget's disease, as has been pointed out by Mocquot and Moutier.[22] There has been no improvement of Paget's description of the disease in its late stage.

The obscurity as to the causation of osteitis deformans can be gauged by the diversity of theories to which it has given rise. A strong case can be made against any one of them. There is no reason to suppose that geographical, climatic or racial factors play any part in its production. The same is true as to sex, occupation, social conditions and status; the disease has been observed in the well-to-do and in the very poor. Its occurrence in different members of the same family is of such infrequency as to render the familial factor insignificant. The disease is one of the second half of life; it has, however, occurred sufficiently often in the young as to eliminate age as an essential cause of its production. Syphilis as a cause of the disease or the disease being a late manifestation of syphilis has had strong support in the past, following especially the teaching of Fournier[23] and Lannelongue.[24] When limited to a single bone, Paget's disease and syphilis can be strikingly alike. However, the unyielding progress of the former in the face of antiluetic treatment, and absence of other syphilitic manifestations in conjunction with a negative Wassermann reaction establish the different identities of the two conditions. Of 28 reported reactions in the literature up to June, 1921, 26 were negative and only 2 positive. Since that time, 33 reactions have been given, of which 9 were positive and 24 negative. Of the 14 cases we have observed, 1 was positive, 4 negative and for the remaining 9 no reactions have been reported. In this connection Deppe's[16] case of contracted syphilis after the development of osteitis deformans should be mentioned. Several writers have reported cases with syphilis. Chartier and Descamps[25] describe one with tabes, and in his second series Paget gives one with a definite syphilitic history.

Other infections and infectious diseases have not been demonstrated as playing a part in causation, the same being also true of intoxications.

Carcinoma appears to be no more frequent than in a like number of patients of the same age. Arthritis of any nature is a complication rather than a part of the picture of osteitis deformans. The frequency of mental enfeeblement and actual dementia is significant. Da Costa[13] calls attention to the very high incidence of sarcoma, and Williams[26] has written of the relationship between osteitis deformans and neoplastic disease.

What, if any, importance is to be attributed to the glands of internal secretion in the production of the disease must be deferred until their function and pathological states are better understood. Paget's disease and glandular disturbance have not been convincingly linked up.

Trauma does not seem to be of importance, although fracture is of frequent occurrence in those subject to this disease, and has been thought to be a direct cause in some instances. It appears more likely that fracture takes place because of the disease rather than the reverse. Léri and Legros[27] report a case where trauma was directly followed by development of the disease in a tibia.

Degenerative lesions of the spinal cord have been reported in association with Paget's disease, but they would seem to be part of the associated arteriosclerosis. No constant or important blood changes have been found. Da Costa et al.,[28] demonstrated in studies of metabolism a marked retention of calcium and magnesium with increased elimination of sulphur in 3 cases. Pescarolo and Bertolotti[29] obtained essentially the same results from urinary studies.

The most striking association is that of circulatory disease, both arterial and cardiac. This incidence is far beyond that in a like number of patients of the same age, both in frequency and in degree. Attention to this has been called by many observers; reported cases of cranial involvement which are accompanied by photographs show tremendous enlargement of the temporal vessels. Especially in the cases of Da Costa,[28] Catola[30] and Ravenna[31] is this pointed out, the latter showing findings of low arterial tension. So great is the degree of enlargement of the vessels that the question arises as to the same process being the basis both of bone and arterial changes.

The onset of Paget's disease has never been described. When the condition is manifest it obviously has existed for some time. The progression of the disease varies in rapidity, in some cases being so slow that there is an apparent arrest; and its duration is always over a period of years. Its tendency is toward the ultimate symmetrical involvement of the entire skeleton. Acute development with rapid spread seems never to occur, and there certainly has been no reported case of recession. In its beginning the bones of the thigh, legs, pelvis and skull are first involved; though no portion of the skeleton can be considered exempt, yet the bones of the forearm, hands and feet are usually found uninvolved.

When once fully developed, the disease proceeds with increasing deformity and its resultant disability. There is rather more enfeeblement than the age of the subject would account for until death supervenes from intercurrent disease, usually cardiac. The condition itself neither causes death nor seems greatly to contribute to that outcome. Some cases go on to complete disability, while on the other hand, wide-spread involvement is not incompatible with both mental and physical activity.

The symptoms found in Paget's disease will vary with the stage of the disease and the parts involved. Often its discovery is accidental, the patient being unaware of the existence of any skeletal changes. What are commonly supposed to be the earliest symptoms—pain, weakness, slight disability, slight bony enlargement—are vague, uncertain, inconstant and often completely lacking; they are such as might accompany any bone or joint condition. When the bony changes are manifest, the disease can be considered as advanced, and if they are sufficiently pronounced, diagnostic.

As to bony enlargement and deformity, the latter is largely a result of the former. There has been much discussion as to the mechanism at work in the production of the deformity of osteitis deformans. The view most generally advanced is that it is produced as the result of weight-bearing by softened bone, though this does not explain the deformities of the skull or upper extremities. Paget himself suggested that the bones increased in length as well as in other dimensions and that the fixation of the extremities of these softened bones by the investing tissues produced the curvature. Clutton[32] clearly demonstrated increase of length in a humerus. At a much later date Scrimger et al.[2] considered that increase of length, fixation by soft tissues and malleability of bone work together to produce the deformity. This view appeals to the writer as being the true explanation of the occurrence, for the reason that the changes have a constancy never observed in any other deforming condition; and further, the bowing is always to the side opposite the greatest mass of soft tissue. The similarity between the illustrations of Paget's disease has been referred to, and it might be said that any two pagetics vary in their deformity only in degree.

Deformity of the skull which has been particularly studied by Léri[33] and Regnault[34] presents the same constancy as that of the trunk and limbs. Léri explains this as being brought about by the interplay of malleable bone, weight of head and the upward thrust of the spine. The writer would add as a determining agent, fixation of the base of the skull by the attached soft tissues. Involvement of the bones of the extremities and trunk would produce no particularly unusual symptoms as compared with the skull. Here the possibilities of the development of peculiar symptoms are, through pressure on cranial nerves, almost endless. Léri has conclusively shown that narrowing of the openings of the skull is of almost constant occurrence. Schuller[35] mentions a case of the disease restricted to one temporal bone with ear symptoms, and the literature records many instances of affections of the organs of special sense. In this connection it should be mentioned that the teeth are occasionally extruded when there is involvement of the alveolar processes. This with involvement of the palate bone can also greatly diminish the capacity of the oral cavity. Abbe[36] has written on the surgical aspect of this alveolar enlargement. One of the cases of Paget's second series[18] had a huskiness of the voice which the author attributed to the enlargement of the hyoid bone which was pronounced. The writer's third case had a trigeminal neuralgia, and in addition an uncertain history of nasal obstruction and dysphagia.

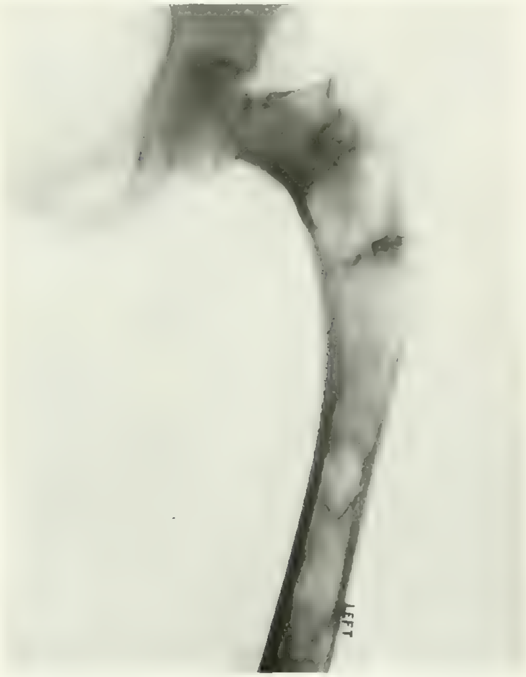


FIG. 1. No. 8840. Osteitis fibrosa cystica. Showing enlargement, textural change, deformity. Contrast with changes of osteitis deformans and note strict diaphyseal location. This patient was under observation four years. An example of osteoplastic metastatic carcinoma is omitted for the reason that a suitable case for reproduction was not available.

Before leaving the matter of special symptoms that might arise when Paget's disease involves the skull, it should be said that osteitis deformans of the skull merits the close attention of the rhinologist, ophthalmologist, otologist, neurologist and the oral surgeon.

Summarizing the symptoms of Paget's disease: they may be considered as almost wholly objective, and are only distinctive late in the affection, at which time they are unique.

From the foregoing it is clear that the diagnosis of Paget's disease must rest almost entirely on objective findings. There should be no difficulty in arriving at a correct diagnosis at the time when the patient presents himself, as usually this is at a late period in the disease and the characteristic objective findings are all present. Early cases of the disease, when encountered incidental to a roentgenological examination, present more difficulties. The writer's experience leads him to believe that the disease is never recognized as long as it remains localized or partially so. It certainly never is unless recourse is had to *x*-ray examination.

In the course of experimentation with the *x*-ray in 1896 by Levi and Londe[37] in Paris, a specimen of dried pagetic bone was used. It is of interest that the exposures were of ten-minute duration. Kienbock,[38] in 1902, claims a characteristic *x*-ray appearance for pagetic bone. The same conclusion was reached at about the same time by Béclère.[39] Practically all subsequent writers on the subject have referred to the *x*-ray appearance in this disease. It has been especially studied by Léri[33] whose work will be referred to again.

Radiographic findings in osteitis deformans may be said to consist, in the order of their importance, in changes in texture, size, form and outline of the involved bone. Of these, the most significant is the increase in bulk, which appears neither as a result of an internal expanding process, nor yet as an apposition or accretion of bone.

Texturally there is early a rarified condition (which at times borders on the cystic) manifested in the cortex of long bones. (See Figs. 1, 2, 3, 4.) For the homogeneous, smooth-textured, compact layer is substituted a wide-meshed, coarsely reticulated structure, in the interstices of which there is a softer tissue relatively deficient in calcium. A later appearance is that of a bone condensation which is irregular, occurring in patches and quite dense. Except as to the last, an appearance simulating this picture is occasionally observed beneath articular cartilage. It is extremely difficult to put into words the radiographic findings in pagetic bones, and no words are of themselves as descriptive as the *x*-ray negative. It must be borne in mind that what was said as to the characteristic findings of Paget's disease varying with the stage of development applies as well to radiographic as to clinical examinations.

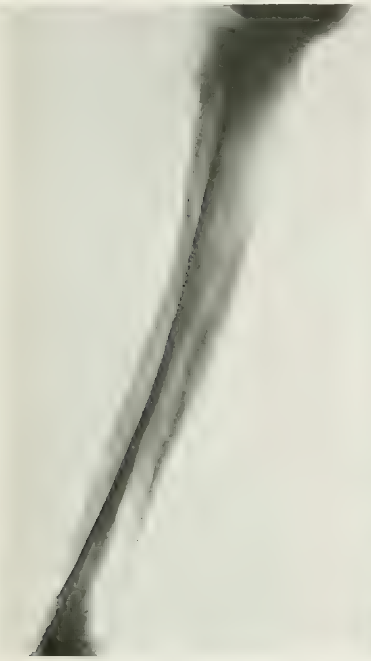


Fig. 2.

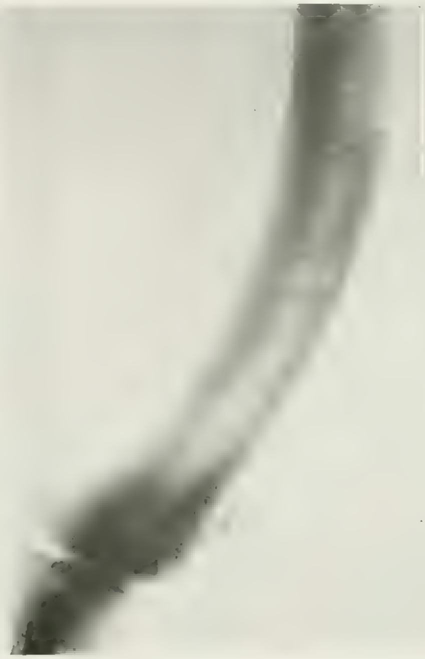


Fig. 3.

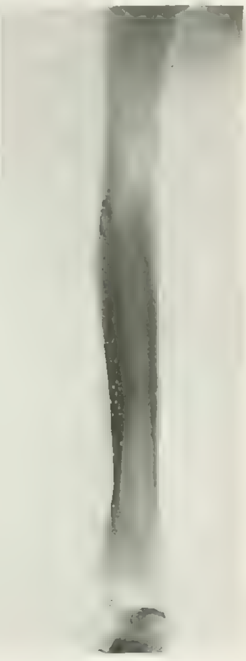


Fig. 4.

Fig. 2. No. 26993. Included to demonstrate early appearance of Paget's disease in tibia. Cortex rarefied, widened and encroaching on medullary cavity. Note that fibula is involved throughout.

Fig. 3. Femur of same patient as in Figure 2. Contrast with Figure 1. Note non-involvement of patella.

Fig. 4. Humerus of same patient as in Figure 2. Note early process in cortical bone on outer aspect at midpoint. Considered earliest manifestation of Paget's disease.

These two processes of rarefaction and condensation go on side by side, and the predominance of one or the other gives a rough indication of the stage of the disease; the former being the primary, the latter a secondary and apparently reparative process. Alterations of form are a constant late finding and are of sufficiently distinctive character as not to be confused with those of other states. The outline of pagetic bone is smooth and of even curvature radiographically, without either projections or superficial losses of substance.

Specifically, osteitis deformans is to be differentiated from any bone condition producing enlargement, deformity, rarefaction and condensation in varying degrees. These conditions are syphilis, tumor, chronic inflammatory states, true hypertrophic changes, osteitis fibrosa cystica, osteomalacia, and when restricted to the skull, hyperostosis cranii and leontiasis ossium. The writer has had no opportunity of observing either osteomalacia, hyperostosis cranii or leontiasis ossium. He would judge from the literature that it is extremely doubtful whether hyperostosis cranii exists as a separate entity. Greater accuracy would seem to classify such cases as either osteitis deformans or leontiasis ossium. Between the last-named and Paget's disease the writer is of the opinion that a differentiation could always be made on the clinical findings. The distinctive point that observers of osteomalacia bring out is that there is no enlargement of bone in this condition and such deformities as occur are irregular, inconstant and tend to angulation. Circumscribed syphilitic involvement of bone is so evidently destructive in nature with loss of substance and accompanying repair, manifested as a sclerosis, that there is little likelihood of confusion with osteitis deformans. The diffuse form of syphilis as typified in the sabre shin has as its distinctive feature such evident condensation that its appearance is, in the majority of instances, characteristic. It is furthermore strikingly diaphyseal in location, while Paget's disease is not so limited.

In the skull, syphilis shows such a definite surrounding zone of reaction combined with such an obvious process of destruction and repair as to distinguish it clearly from osteitis deformans. Of neoplasm affecting bone, only those capable of producing ossification should cause confusion. These are the new growths originating in bone and metastatic osteoplastic carcinoma; the former produces enlargement either by an expanding process from within or as an external accretion to the bone, the finding of which differs from the even enlargement of Paget's. Osteoplastic carcinomatosis of bone does not show a symmetrical increase in size; such increase as does take place is usually asymmetrical and definitely the result of irregular deposition of newly-formed bone. In place of rarefaction there is usually a great increase of bone density.

Fig. 5.

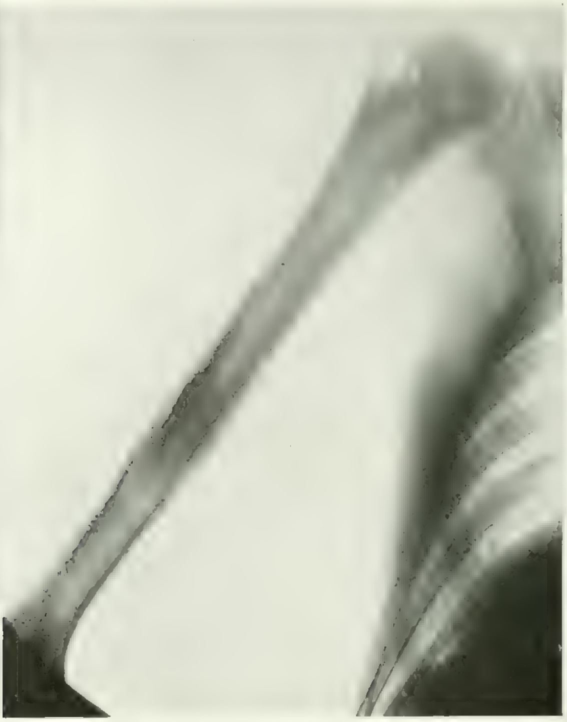


Fig. 6.

Fig. 5. Case I. Upper half of left femur and adjacent portion of pelvis, showing characteristic changes in both. Note deformity (below) of old fracture and fracture line above.
Fig. 6. Case I. Humerus showing characteristic bone change.

Diffuse involvement of the skeleton by metastatic soft tumors might produce a condition remotely resembling the rarefied stage of Paget's disease.

Chronic inflammatory states of bone should be readily differentiated because of the predominance of repair processes; and hence great sclerosis, irregularity of enlargement and outline, the presence of sequestra, and such deformity as may exist will hardly be of the even curvature of Paget's disease.

Osteitis fibrosa cystica should be distinguishable from Paget's disease by history and clinical findings. There is found a diaphyseal process of medullary origin. Hypertrophic states in bone are so frankly increase in size of normal tissue that they would present no difficulties.

A description of 4 selected cases that have come under the observation of the writer follows:

Case I. No. 6-54. White, male, aged fifty-three. Nothing striking in history until the forty-ninth year when the shaft of the left femur was fractured in a fall. Prompt satisfactory union; six months later again fractured the same femur at a slightly higher level, again with good repair. *X*-ray examination at that time raised the question of the presence of sarcoma.

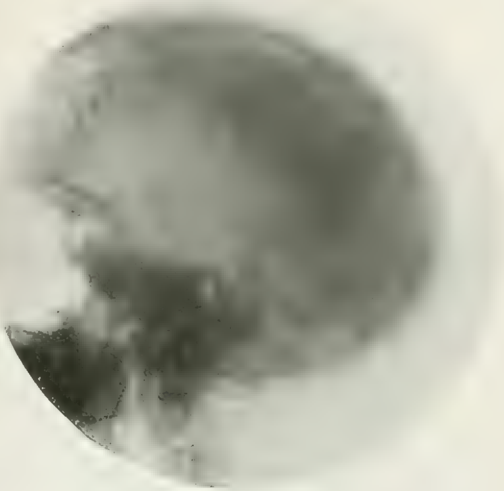


FIG. 7. Case I. View of skull showing typical involvement of Paget's disease.

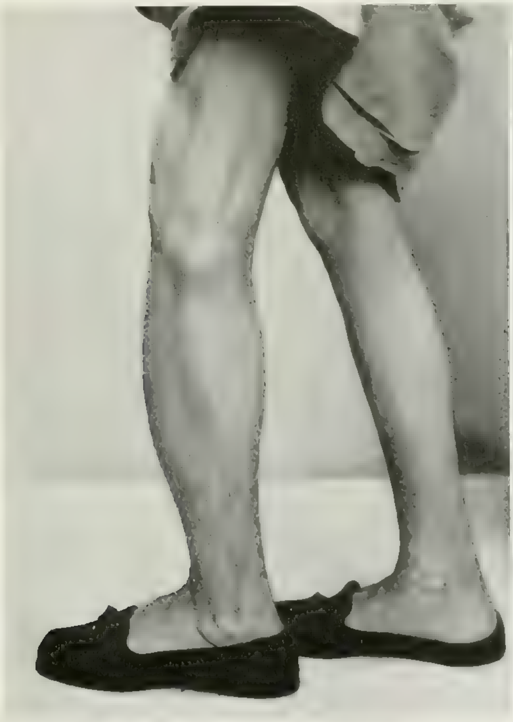


FIG. 8. Case II. Photograph of left leg, showing forward and outward bowing.

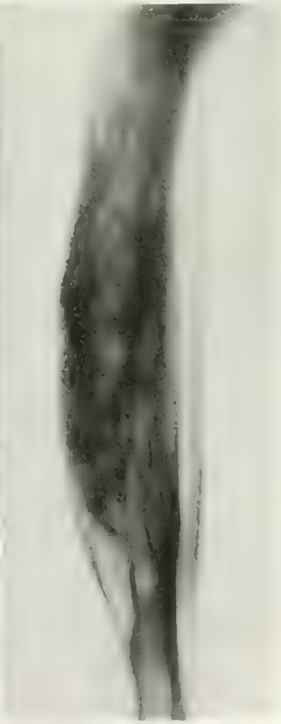


FIG. 9. Case II. Roentgenogram of left leg.

Entered the Barnes Hospital Feb. 16, 1920, for study, having had the lower end of the right humerus fractured as the result of considerable violence. Examination revealed nothing bearing on the case except the fractured humerus and an enlarged left femur. No deformities noticed.

Laboratory examinations including Wassermann reaction were negative. The blood calcium was 13.4 mg. per 100 ml. of blood serum. *X*-ray examination showed the following: "Typical appearance of Paget's disease in the upper portion of the left humerus, lower portion of the right humerus, upper half of the left femur (See Figs. 5 and 6) left half of the ilium and sacrum and in the skull. The last is enormously increased in thickness throughout the calvarium. (See Fig. 7.) The outline of the inner and outer tables is entirely lost. The left femur shows unsymmetrical enlargement at the site of the fractures. The left humerus shows similar processes involving the cortical bone, as is observed in the tibia of the following case.

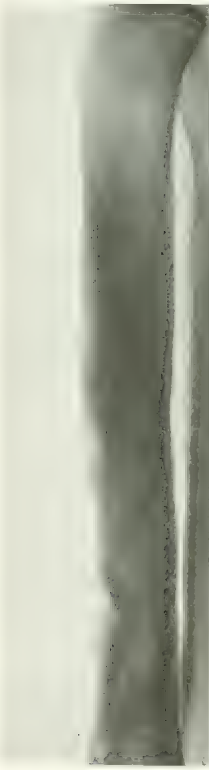


Fig. 10.

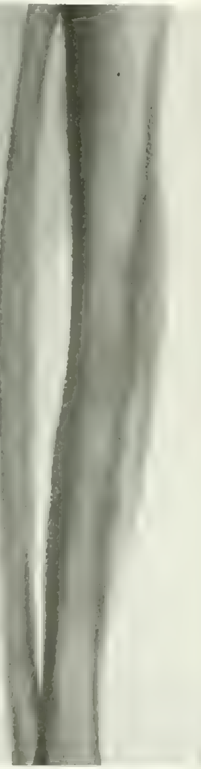


Fig. 11.

Fig. 10. No. 10150. Changes produced by antecedent osteomyelitis and surgical operation. Introduced for contrast with Figure 9, Case II.

Fig. 11. No. 8192. Syphilitic osteitis. Introduced for contrast with Figure 9, Case II.

Case II. No. 6776. White, female, aged fifty-eight. History irrelevant to condition up to four years ago when she had an onset of a peculiar train of symptoms consisting of nervous tremors and pain over the left side of the body. These quite indefinite symptoms have continued and she has had much pain, with some enlargement of the left leg.

Examination reveals nothing striking except a spindle-shaped enlargement of the left tibia which is bowed out and forward; and evidence of a mild nephritis. There were no laboratory findings of moment and the Wassermann reaction was negative. The greatest circumference of either leg was:

rt. 27.3 cm. lt. 29.5 cm.

The real length of either lower extremity:

rt. 78.5 cm. lt. 79 cm.

X-ray examination of the left leg showed characteristic appearance of Paget's disease. (See Figs. 8 and 9.) The skeleton was elsewhere negative except for a slight projection from the shaft of the left humerus.

In the course of palpating the affected leg, it was remarked that it was strikingly warmer than its fellow. To determine whether this was a true, constant elevation and not simply a temporary phenomenon, a series of diurnal observations over a period of a week was made. Exact methods of measuring this rise in temperature were not available, so recourse was had to skin thermometers applied under like conditions on the two sides. These readings were made over both tibiae, where they were subcutaneous, and also over the thickest portion of each calf. Simultaneously the oral temperature was taken. The observations extended over a period of seven days and showed an average of 4°C. higher temperature over the affected than over the opposite leg, the oral temperature remaining normal. To see what, if any, part the circulation played in the production of this phenomenon, observations[1] were made on the volume flow of blood to the limbs by the method of Hewlett and Van Zwaluwenburg.[40] Many observations were made on the four extremities, averaging as follows:

lt. leg (affected)	rt. leg (sound)
2.83	1.14
lt. arm	rt. arm
2.95	3.02

Cutaneous temperature of the lower extremities, taken simultaneously, gave the following results:

Tibia surface	lt. 34° C.	rt. 31.5° C.
Calf	28° C.	28.5° C.
Oral temperature	37° C.	

When this increase in surface temperature over the affected bone was noted the writer was unaware that this observation had previously been made. The literature reveals that this phenomenon has been recorded by several writers. In Paget's second publication he mentions it as occurring over the tibia in two of his cases. Before his time B. Schmidt[41] in 1874 records the occurrence of increased heat over the tibia in a condition which from his description was unquestionably osteitis deformans and to which he applied that designation. Pozzi[42] mentions a local elevation of temperature without fever in a case of Oliers. Von Kutscha[43] in 1906 records a similar finding. Chartier and Descamps[25] noted this occurrence over the tibia, right arm and right side. Bartlett,[44] 1909, also noted the phenomenon and stated his belief that it was an early finding, and that it was also found in Eades's case. Gaenslen,[45] 1914–15, noted an increase of temperature over an affected tibia and suggested a focal infection as a remote cause. Da Costa[13] in 1921 mentions that increase of surface temperature is an inconstant symptom of Paget's disease. Klippel and Pierre-Weil[46] are the only writers that have devoted particular attention to this symptom and they consider that it is due to a local increased thermogenesis, and not to an increased radiation, although they admit that their methods of investigation were crude and incapable scientifically of proving their contention. They were very clear that there was no evidence of local inflammatory process as ordinarily seen, nor was there local evidence of increased vascularity.

The one suitable case that has come under observation on whom a comparative study of a different condition could be made was No. 8192, a syphilitic with a concurrent tuberculosis. The Wassermann reaction was 100 per cent inhibition, substantiated unmistakably by clinical evidence of the disease. The radiographic examination revealed a typical sabre shin on one side only. (See Fig. 11.) Analogous temperature readings were made over both tibiae and were practically identical showing, however, the fluctuations of temperature which were evidently a part of his general febrile movement. Unfortunately the volume flow of blood could not be determined in this case.

Case III. No. 4669. White, female, aged fifty-eight. History unimportant until 1909, at which time, following the extraction of a left upper molar, pain began in the upper portion of the left side of the face. In 1912 had an operation for "removal of bones in the nose." The nose was treated subsequently over a period of four years because of obstructed breathing. Since 1916 has had frequent attacks of neuralgic pain over left side of face. During the past few months has had slight dysphagia. Entered hospital Oct., 1917 for tumefaction of left superior maxilla and neuralgia.

Physical examination shows prominence of the left side of the face which is tender. Teeth are widely spaced, the alveolar processes prominent and the upper incisors directed backward. There was an evident trigeminal neuralgia.

Gasserian operation done with resulting incomplete relief but great amelioration of neuralgic pain. At operation there was much difficulty encountered because of the great vascularity of the skull, which was increased in thickness.

X-ray examination revealed the following: There are no findings except in the skull and bones of the face. (See Figs. 12, 13 and 14.) There is thickening of the calvarium, chiefly through an increase in width of the outer table. Beginning in the left vertical portion of the frontal bone, about 2 cm. above the orbital roofs and as far forward as the frontal sinus, there is a band of rarefaction extending backward to a point above the petrosal bone. It extends from the base well up into the calvarium. The left superior maxilla is enlarged and decreased in density and projects beyond the mandible. The upper central teeth are directed sharply backward and have little bony investment about their fangs anteriorly.

---

[1] I wish to acknowledge my indebtedness to Dr. W. S. Priest, late resident of Barnes Hospital, for making these observations.

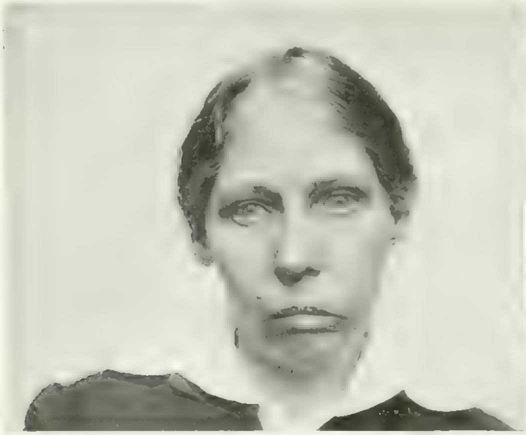


Fig. 12. Case III. Photograph showing asymmetry of face as the result of enlargement of bones of left side of face.

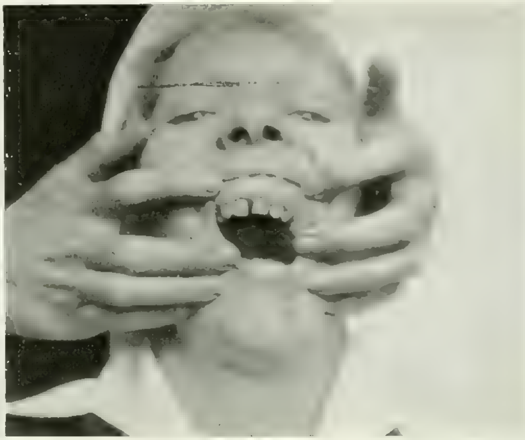


Fig. 13. Case III. Showing enlargement of alveolar process of upper jaw and separation of teeth.

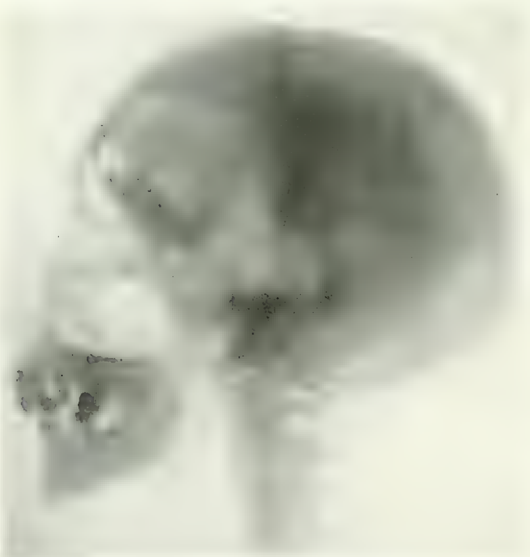


Fig. 14. Case III. Roentgenogram of skull, showing rarefied area in frontal bone, massive alveolar process of upper jaw, displacement of anterior upper teeth and their lack of bony investment.

Examination of April, 1920, shows increase in size of the rarefied area previously noted and an operative defect. The maxillary changes are more pronounced than at the time of the previous examination.

The fourth history is included in this series as a case of Paget's disease diagnosed on *x*-ray evidence alone; such evidence being deemed conclusive enough to justify the diagnosis. A single lumbar vertebra (the third) appeared in the *x*-ray plate with a symmetrical enlargement and the textural changes which characterize Paget's disease, viz., a combination of rarefying and condensing osteitis proceeding simultaneously. (See Figs. 15 and 16.) Necessarily there can be no deformity except the enlargement. *X*-ray examination of the remainder of the skeleton showed it free from involvement.

Case IV. No. 86228. White, male, fifty-five years of age. Clinically the history shows nothing of moment to bear out the diagnosis. The patient presented himself at the dispensary because of pain in the back and along the course of the sciatic nerve. Physical examination was negative except for a muscle spasm in the lumbar region. Wassermann reaction negative. This case is considered one of the early so-called mono-osteitic type.

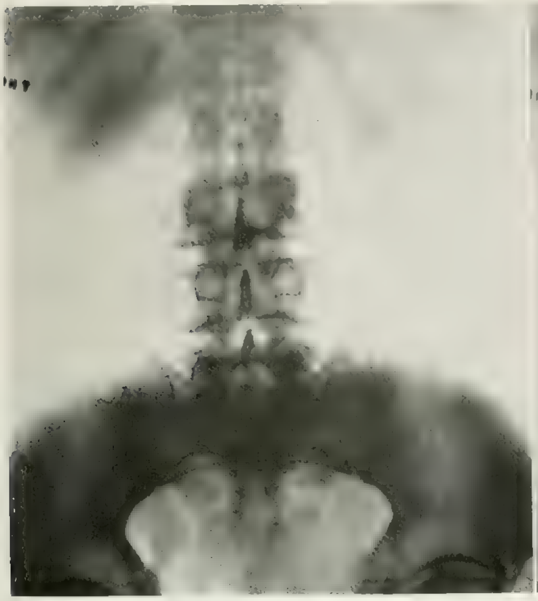


Fig. 15. Case IV. Roentgenogram of lumbar spine showing enlargement and textural change in third lumbar vertebra.

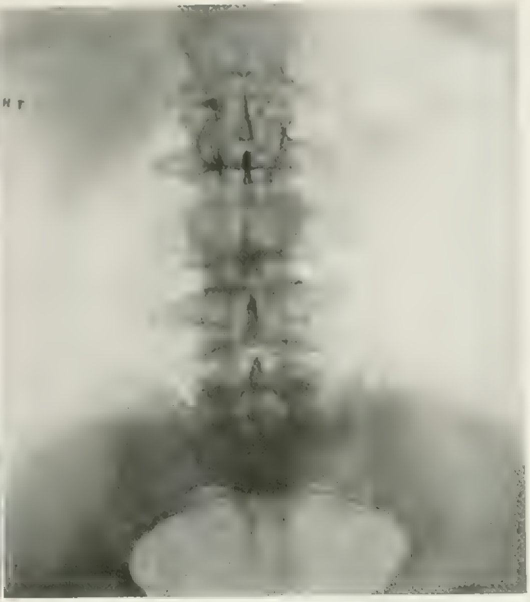


Fig. 16. Case IV. The same as Figure 15, retouched to bring out features mentioned.

Paget calls attention to the great vascularity of pagetic bone, as have many writers since. Several have observed the enlargement of temporal vessels in cases of skull involvement which they reported, especially Catola[30] and Pescarolo and Bertolotti.[29] The illustrations of their cases show a pronounced increase in size of the temporal vessels, and this is also observable in Da Costa's[13] latest case. Great vascularity was apparent at the time of operation on the writer's third case, as has been mentioned. Increased vascularity of bone in Paget's disease can be considered as established beyond doubt. It exceeds in degree that of some types of tumor. The significance of its occurrence is not apparent; it certainly exceeds increased vascularity observed in infectious states of bone. In fact, it is of such degree that the question arises as to its being the cause of the osteitic process. To the writer it seems that the process in the bone is one producing increased vascularity, but this in turn is hardly sufficient to explain the local increase in temperature.

The nature of this disease can be said to be at present entirely unknown. Paget, in discussing this point, states that it is neither of a hypertrophic nor neoplastic

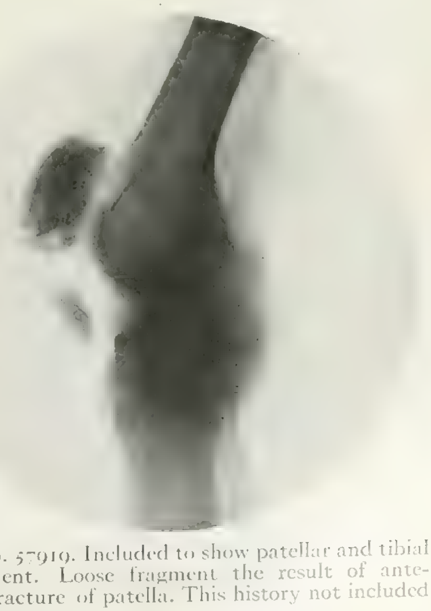


Fig. 17. No. 57919. Included to show patellar and tibial involvement. Loose fragment the result of antecedent fracture of patella. This history not included in report.

nature, although it has some features of each. He concluded that it more closely resembled an inflammatory process. It is pertinent in this connection to call attention to the unique findings of Hudelo and Heitz,[17] in whose case the bones of the leg had fused into a homogeneous mass of pagetic bone.

Before closing the discussion of increased vascularity in Paget's disease, the evidence points to the former being sequential to the latter when the bone changes of hypertrophic pulmonary osteoarthropathy and those found in local circulatory obstruction are borne in mind. Some other factor than simple engorgement must come into play in the production of Paget's disease.

SUMMARY

1. Although Paget's disease is not common, it cannot be considered rare. In spite of the ratio of incidence reported by Carman and by LeWald, the probabilities are that if sufficient *x*-ray search were made, the disease would be more frequently discovered.

2. This disease gives a characteristic *x*-ray appearance and the diagnosis is justifiable on *x*-ray examination alone if such examination reveals in the order of their importance, textural changes of bone (a combination of rarefaction and condensation) and symmetrical increase in bulk and deformity.

3. From the standpoint of treatment it is useless to study Paget's disease at present. It should, however, be carefully investigated, for the reason that there might be uncovered a function of bone other than the rather passive ones of support and the housing of blood-forming organs. It is conceivable that aberrance of this possible function may produce the disease known as osteitis deformans.[1]

BIBLIOGRAPHY

1. Paget, J. *Tr. Med.-Chir., London*, 1877, lx, 37.
2. Gruner, O. C., Scrimger, F. A. C., and Foster, L. S. *Arch. Int. Med.*, 1912, vii, 641.
3. Schirmer, K. H. *Centralbl. f. d. Grenzgeb. d. Med. u. Chir.*, 1908, xi, 561.
4. Legros, G., and Léri, A. *Nouv. Icon.*, 1909, xxii, 24.
5. Da Costa, J. C., Funk, E. H., Bergheim, O., and Hawk, P. B. *Pub. Jefferson Med. Coll. & Hosp.*, 1915, vi, 1.
6. Leahy, S. R. *Neurol. Bull.*, 1918, i, 325.
7. Watson, A. *Intercolon. Q. J. M. & S.*, 1894, i, 45.
8. Jamieson, L. *Australas. M. Gaz.*, 1897, xvi, 14.
9. Lidwill, M. C. Ibid., 1904, xxiii, 227.
10. Connolly, H. W. *Med. J. Australia*, 1916, i, 283.
11. Matsuoka, M. *Deutsche Ztschr. f. Chir.*, 1909, cii, 515.
12. Hewitt, W. R. *Interstate M. J.*, 1909, xvi, 561.
13. Da Costa, J. C. *S. Clin. N. Am.*, 1921, i, 47.
14. Carson, E. P. *Arch. Int. Med.*, 1922, xxx, No. 6.
15. Clopton, M. B. *Interstate M. J.*, 1906, xiii, 223.
16. Deppe, A. H. *Interstate M. J.*, 1917, xxiv, 772.
17. Hempelmann, L. H. *M. Clin. N. Am.*, 1920, iv, 820.
18. Paget, J. *Tr. Med. Chir. London*, 1882, lxv, 225.
19. Locke, E. A. *Med. Clin. N. Am.*, 1918, i, 947.
20. Carman, R. D. and Carrick, W. M. *J. Radiol.*, 1921.
21. Thibierge, G. *Arch. gén. d. méd.*, 1890, i, 52.
22. Mocquot, P. and Moutier, F. *N. iconogr. de la Salpêtrière*, 1905, xviii, 61.
23. Fournier. *Bull. méd. Paris*, 1903, xvii, 301.
24. Lannelongue. *Bull. Acad. de méd.*, 1903, xlix, 209.
25. Chartier and Descamps. *N. iconogr. de la Salpêtrière*, 1907, xx, 84.
26. Williams, W. R. *Lancet*, 1909, ii, 1543.
27. Léri, A. and Legros, G. *N. iconogr. de la Salpêtrière*, 1912, xxv, 334.
28. Da Costa, J. C., Funk, E. H., et al. Abstract *Proc. Am. Soc. Biol. Chemists*, 1914, 30.
29. Pescarolo, B., and Bertolotti, M. *N. iconog. de la Salpêtrière*, 1909, xxii, 253, 266.
30. Catola, G. Ibid., 1910, xxiii, 276.
31. Ravenna, F. Ibid., 1909, 524.
32. Clutton, H. H. *Tr. Path. Soc. London*, 1887–8, xxxix, 259.
33. Léri, A. *N. iconog. de la Salpêtrière*, 1913, xxvi, 452.
34. Regnault, F. *Bull. et mém. Soc. anat. de Par.*, 1912, lxxxvii, 385.
35. Schüller, A. Roentgen Diagnosis of the Diseases of the Head. St. Louis, 1918.
36. Abbe, R. *J. Am. M. Assn.*, 1918, lxx, 371.
37. Levi, L. and Londe, A. *N. iconog. de la Salpêtrière*, 1897.
38. Kienbock. Quoted by Hurwitz, S. H. Am. J. Roentgenol., 1915, ii, 755.
39. Béclère, A. *Bull. et mem. Soc. med. d. hôp. de Paris*, 1901, 3 s., xviii, 929.
40. Hewlitt and Van Zwaluwenburg. *Heart*, 1909, i, No. 2.
41. Schmidt, B. *Arch. d. Heilk.*, 1874, xv, 81.
42. Pozzi, S. *Cong. franc. d. chir. Proc. verb.*, 1885, Paris, 1886, i, 631.
43. Von Kutscha. *Mitt. d. Gesellsch. f. inn. Med. u. Kinderh.*, Wien, 1906, v, 127.
44. Bartlett, C. J. *Yale M. J.*, 1909–10, xvi, 367.
45. Gaenslen, F. J. *Am. J. Orthop. Surg.*, 1914–15, xiii, 96.
46. Klippel and Pierre-Weil. *N. iconogr. de la Salpêtrière*, 1909, xxii, 1.
47. Hudelo, L. and Heitz, J. Ibid., 1901, xiv, 415.

---

[1] I wish to acknowledge my indebtedness to Dr. George Dock for the privilege of studying certain of these cases which were on his service at the Barnes Hospital

COMPLETE ANTERIOR DISLOCATION OF THE DISTAL EPIPHYSIS OF THE FEMUR*

BY THEODORE WEST, M.D.

RYE, NEW YORK

A REVIEW of the literature will show reports of numerous cases of dislocation of the distal epiphysis of the femur, with or without an accompanying fracture. It is also recognized that dislocation in the anterior direction is the most common. Notwithstanding the number of these cases reported, it is a condition not frequently seen and probably less often recognized by the average practitioner, since without *x*-ray examination its detection is difficult. Hence, in districts where this diagnostic aid is not available the true condition may easily be mistaken for a simple fracture of the lower end of the femur.

The importance of recognizing these cases lies, first, (in extreme cases) in the immediate danger to the patient; second, in the prognosis. The danger is caused by the compression of the popliteal vessels and the subsequent gangrene of the leg. Poland[1] refers to several cases with this unfortunate result, in which the true nature of the injury was not determined until the amputated extremity was dissected. The prognosis must be guarded since any injury to an epiphyseal line may destroy the center of growth, causing the bone thus affected, to be shorter than its fellow.

This epiphysis is the first to appear, being present "in utero" and demonstrable by the *x*-ray at birth. It is also the largest one in the body, and the forces exerted upon it, due to the arrangement of the muscles and ligaments attached thereto, render it the more liable to dislocation. Its superior surface resembles a shallow saucer, and has an anterior lip that extends upward a short distance on the diaphysis. It is firmly attached to the tibia by the crucial and lateral ligaments of the knee-joint, and by the gastrocnemius and popliteus muscles.

The gastrocnemius arises mostly from the posterior surface of the condyles of the femur, only a few fibers coming from the diaphysis. The origin of the popliteus is the outer surface of the external condyle, posterior to its center. The plantaris sometimes has a few fibers of origin from the posterior surface of the condyles. The internal lateral ligament, together with the tendons of insertion of the internal hamstring muscles, extends from the inner surface of the internal condyle, posterior to its center, to the inner and anterior part of the tibia, just below its upper border.

With this arrangement it is evident that the tendency of both the ligaments and the muscles is to push the epiphysis forward, once its union with the diaphysis has been disturbed. It is also easy to understand how the tibia may act as a powerful lever to pry it loose.

Etiology. Age: This condition may occur at any time before ossification of the femur is complete (this is usually about the twenty-third to the twenty-fifth year). Truesdell[2] reported a case caused at birth by breech extraction, and Poland[1] mentions a case found in a fetus. The greater number occur between the tenth and twentieth years, due to greater and more violent activity during this period.

Sex: Slightly more common in males because of their rougher sports.

Trauma: There is a difference of opinion as to whether direct or indirect violence is the more common cause, but the evidence, seems to be slightly in favor of the latter. Any violence applied to the thigh, while the leg is held in a fixed position (or vice versa) may produce this dislocation. Probably one of the most frequent causes is a fall with the foot held fixed and elevated. Thus a fall from a chair, with the foot held in the rungs, or from a wheel with the ankle caught in the spokes, is an almost classical cause. Cases are reported in which the only trauma was an unexpected step downward. The traction and manipulation used in setting a dislocated hip, or the traction applied in the treatment of a tubercular hip have been known to cause the condition.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

[1] Poland, John. Traumatic Separation of the Epiphyses. London, 1898.

[2] Truesdell, Edward D. Birth Fractures and Epiphyseal Dislocations. New York, 1917.

Predisposing factors: Any disease affecting the growth or development of the bones.

The following case is so typical in many respects that it seems to merit reporting:

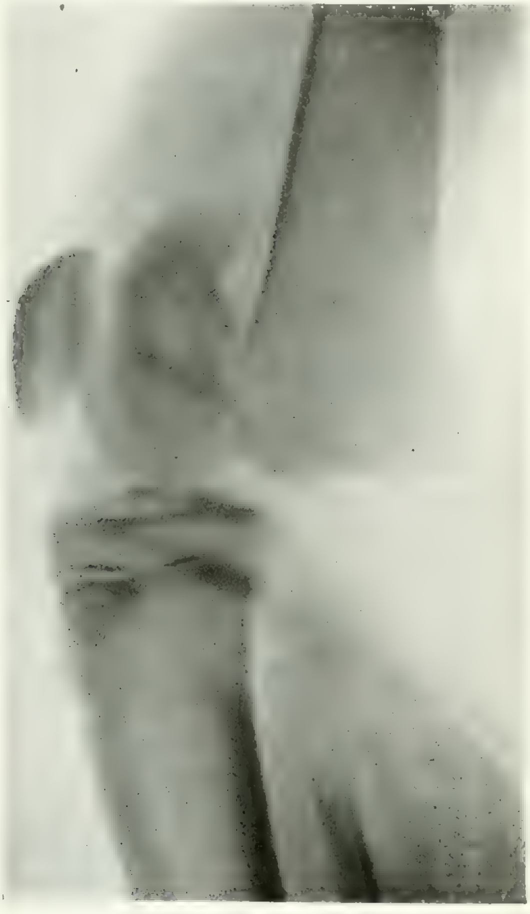


Fig. 1. Lateral (before reduction).

Female, aged thirteen. Well developed and nourished; previous and family history indicate no predisposing diseases. Patient was climbing out of a farm wagon, her right foot placed between the spokes of the wheel, near the hub. She lost her balance and fell backward, striking the ground, but her foot remained wedged between the spokes, with the knee apparently flexed.

After the foot had been disengaged from the wheel, it was found that she could not extend the leg, and on physical examination a large, hard protuberance was seen on the anterior surface of the thigh, at the knee. Under anesthesia the leg was extended and a pillow splint applied. In this position the same protuberance was noted. The following morning the leg was swollen and slightly cyanotic, but otherwise there was no change in the appearance.

X-Ray Examination. Lateral view: The

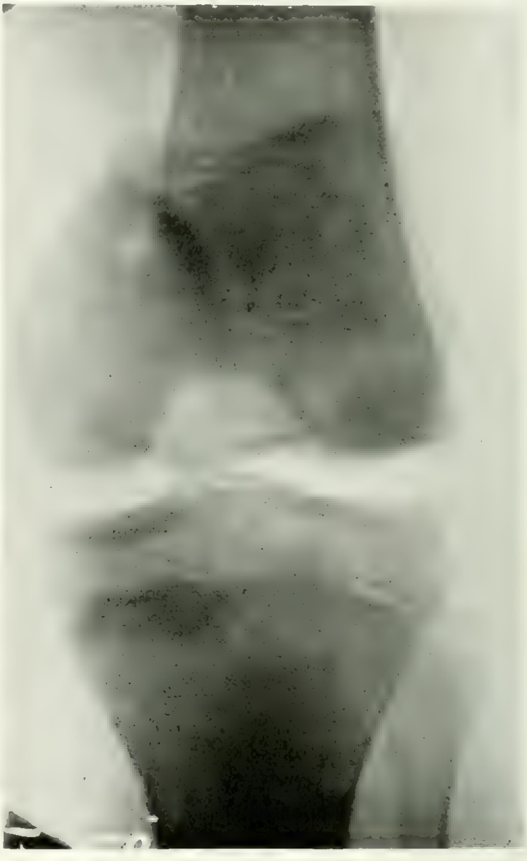


Fig. 2. Anteroposterior (before reduction).

distal end of the diaphysis was displaced backward, its anterior border being almost on a line with the posterior border of the tibia, and its posterior border directly subcutaneous. Its lower border was irregular and rough. The condyles were seen, lying between the patella and the diaphysis; their inferior borders directed anteriorly, their posterior borders directed downward; their anteroposterior axis parallel with the vertical axis of the shaft.

Anteroposterior view: But little information could be gained from this position, except that the condyles could not be oriented, and that the diaphysis ended very abruptly in a roughened line, having a shallow notch in its center. A large, roughly circular shadow was seen covering the lower four inches of the diaphysis, and overlapping both sides of it.

The patient was again given an anesthetic; the leg was flexed and traction was applied to it; pressure in the direction of the foot was exerted on the epiphysis, which was felt to return to its proper position in relation to the diaphysis; the leg was then extended and a cast applied.

Subsequent *x*-ray examination showed the reduction to be complete. The recovery was uneventful.

Unsuccessful efforts have been made to have the patient returned for further examination to determine if there is any difference in the length of the thighs.

SECONDARY SIGNS OF GALL-BLADDER PATHOLOGY*

BY RALPH D. LEONARD, M.D.

BOSTON, MASSACHUSETTS

DURING the last few months it has been called to our attention that in some of the leading hospitals of this country the *x*-ray is not looked upon with favor as an aid in the diagnosis of gall-bladder disease. Even within a few weeks a patient was referred to our office with the story that he had been recently *x*-rayed in a neighboring institution for gall-bladder trouble. His examination proved negative, but he was informed by one of the staff that the evidence was practically worthless, as in their experience the *x*-ray was of help in less than 2 per cent of their gall-bladder cases. This institution seems to lack nothing in the way of material and equipment, and the personnel of its staff consists of leaders in the medical world.

Observing this atmosphere of doubt and skepticism emanating from the Roentgen Department of a great teaching hospital, we naturally have become somewhat disturbed.

We began to inquire of ourselves, "Can it be, after these years of apparent greater or less success in using the *x*-ray for the diagnosis of gall-bladder disease, that all this time we have been mistaken in our conclusions, that we unwittingly have been fooling not only the patients and our consultants, but also ourselves?" With such an array of medical talent apparently diametrically opposed to one's firm belief in regard to the *x*-ray, it would behoove an ordinary roentgenologist to take a very exhaustive account of stock, carefully distinguishing between fact and fancy, before attempting to override this solid barrier of unbelief.

Is it possible to harmonize satisfactorily or explain these two extreme points of view? Can our claims for the *x*-ray in gall-bladder work stand the test of scientific investigation, or are they built on shifting sand and ready to collapse under the slightest stress?

Ten years' experience in the search for the elusive gall-stone has shown not only some vulnerable points in our own armor, but also some weaknesses in the logic of our skeptical friends. I want briefly to discuss some of these lessons which experience has taught us, with the hope that this difference of opinion can be shown to be more apparent than real.

First, let us consider the matter of statistics. Figures themselves do not lie, but certain use of figures may sometimes give a false impression and render the writer justly liable to adverse criticism. Correct conclusions can never be drawn from premises which are false or incomplete. Gall-bladder statistics are usually derived from premises which of necessity are incomplete, and for this reason are not only worthless, but may be almost vicious, in that they give a false sense of security. This fact has long been appreciated by the great majority, but unfortunately, even today we read of men attempting to prove the success of their gall-bladder work by quoting various high percentages of correct diagnoses.

---

* Read at the Midwinter Meeting of the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J., Jan. 25–27, 1923.

The only cases in which one's gall-bladder diagnoses can be checked up are those which come to operation. Now, it requires no great stretch of the imagination to appreciate that, in any condition serious enough to warrant surgical treatment, the symptoms are going to be fairly definite and the local condition sufficiently advanced to make comparatively easy both correct clinical and *x*-ray diagnoses. It is evident then, that diagnostic results computed on operated cases alone will have an abnormally low percentage of errors.

Furthermore, these operated cases form a comparatively small part of all those coming for gall-bladder examinations. As for that great number of cases in which the clinical picture is doubtful, which are not ill enough to require surgery, and in which the *x*-ray might be of the greatest value, in none of these can the correctness of the *x*-ray be confirmed. Not infrequently, the high percentages based on operated cases are wrongly applied to this great mass of unproven cases.

Another source of possible statistical misinformation is the not uncommon habit of including in one's figures what are termed correct—"negative" opinions. Here again the law of chances helps to boost the percentages of what seem to be correct *x*-ray diagnoses. For example, some men routinely examine the gall-bladder area in all cases coming for a gastrointestinal examination. In the great majority of cases, for example, those showing a chronic appendix, intestinal cancer, duodenal ulcer, etc., the gall-bladder area will be reported as negative. Many of these patients come to operation and after the appendix or ulcer has been removed the surgeon examines the gall-bladder and reports to the roentgenologist that it was normal. That case is immediately listed as a correct *x*-ray diagnosis of the condition of the gall-bladder. Theoretically, this may be an honest procedure. Practically, however, it is very misleading as far as giving any true indication of the real value of the *x*-ray in diagnosing gall-bladder disease is concerned. In other words, in this class of cases, the roentgenologist does not need to expose even one film. If he simply will pass a negative opinion as to the gall-bladder, the percentage of correct guesses will be very nearly 100.

Furthermore, the roentgenologist may be greatly assisted in obtaining a high percentage of positive diagnoses of gall-bladder pathology, if he has a careful and persistent pathologist. I think it is worth considering that the same may be true of the gall-bladder that is frequently stated of the appendix: "No appendix is ever normal in adults over twenty-three years of age." If your pathologist will hunt long and carefully enough, he is likely to find some slight evidence of chronic inflammatory changes in every adult gall-bladder. Of course, this change may have nothing to do with the patient's symptoms, but nevertheless it saves the roentgenologist from an error.

In addition to the fallacy of statistics there is another habit which may be legitimately questioned. It is not impossible that, in interpreting gall-bladder films, the roentgenologist may be unduly influenced by the clinical evidence.

If a jaundiced woman of middle age comes for examination with pain under the right costal border radiating to the right shoulder, it is not unreasonable to expect that the roentgenologist will search a little harder or use his imagination a little more in seeking gall-bladder evidence in this type of patient, than in the case of a young man who presents himself for a diagnosis, complaining of distress in the median line two hours after eating, with a story of vomiting blood.

I think it is fair to admit that not infrequently a high percentage of correct diagnoses are claimed for the *x*-ray when as a matter of fact, the roentgenologist is enough of a clinician to be a very good "guesser" when it comes to reading the *x*-ray films.

Let me suggest, therefore, in making claims for the value of the *x*-ray in gall-bladder work, that we clearly distinguish between clinical and *x*-ray evidence, putting the credit for the diagnosis where it belongs.

Again, in discussing from time to time with various roentgenologists the reasons for their apparent lack of success in this line of work, I have observed that the most frequent cause of failure seems to lie in a lack of appreciation of the relative value of the different classes of *x*-ray evidence of gall-bladder disease.

We have been accustomed to divide *x*-ray evidence of gall-bladder pathology into two groups: direct and indirect. In the class of direct evidence we put the demonstrable stones and the visible gall-bladders. In the class of indirect or secondary evidence are put the demonstrable changes produced in other organs by gall-bladder disease.

I wish to emphasize most strongly that of these two classes, the class of indirect or secondary evidence is by far the more important in the establishing of an *x*-ray diagnosis of gall-bladder pathology. I feel that probably two thirds of our diagnoses are based solely on this class of indirect evidence. I also believe the converse is true: that probably less than a third of all cases of gall-bladder pathology will show definite direct evidence, such as gall-stones or a visible gall-bladder.

It is evident, therefore, that without an intelligent comprehension of what this secondary evidence is and an appreciation of its value, one cannot hope to find the *x*-ray of help except in a comparatively small percentage of the gall-bladder cases.

I will not attempt at this time to describe in detail the various types of secondary evidence, but will simply enumerate the more common phases.

1. The first group of indirect evidence includes the pressure deformities. Due perhaps to increased internal tension or to a thickening of its wall, the gall-bladder may produce unusual pressure on some of the adjacent organs. The duodenum is most frequently affected. The typical curve of the gall-bladder may be seen on the external surface of the duodenum, or occasionally on its superior surface, the latter best observed in the lateral view. This pressure from above frequently produces a characteristic flattening of the cap almost pathognomonic of gall-bladder disease. The antrum of the stomach, particularly with gall-bladders which are enlarged, may also show characteristic pressure deformities.

With considerably enlarged bladders, as in cases of hydrops, one may find the effects of pressure on the hepatic flexure or proximal transverse colon.

2. Another group of secondary evidence consists of those changes due to adhesions. This group may be divided into: *fixation* of adjacent organs by adhesions, and deformities in outline of adjacent organs from adhesions. In the group of fixation due to adhesions, the fluoroscope as well as the plates is of particular advantage.

The stomach and the first portion of the duodenum may be abnormally fixed over to the right side. The second portion of the duodenum, which usually lies parallel to the long axis of the body, may be displaced in varying degrees to the right, in some cases lying almost horizontal along the under surface of the liver, or again appearing to hang as a festoon outlining the lower pole of the gall-bladder.

The hepatic flexure and proximal transverse colon occasionally show evidence of fixation due to gall-bladder pathology. The proximal transverse colon may be angulated and displaced upwards, a condition occasionally termed as a pseudo-hepatic flexure.

The first portion of the duodenum may show an *irregular outline* due to deforming adhesions. The duodenum may be constructed as by a single band, or present a serrated edge as though an entire surface were glued or adherent to the gall-bladder. The stomach may show various types of adhesion deformities, all of which differ from the deformities due to gastric lesions.

The colon occasionally shows deformities characteristic of gall-bladder adhesions, the most common of which is a tab-like projection pointing upward and inward from the superior surface of the proximal transverse colon.

3. In the study of the stomach and duodenum for typical gall-bladder spasm, the fluoroscope is again of value. I believe there is room for considerable advance in this particular field of gastric reflex. It is frequently stated by clinicians that a diseased gall-bladder is probably the most

frequent cause of reflex gastric symptoms. It is, therefore, reasonable to expect some type of gastric spasm more or less characteristic of gall-bladder disease. We, as well as others, have observed that gall-bladder disease seems not infrequently to be associated with a rather extensive tonic contraction of the pyloric half or third of the stomach. When this type of spasm is observed persisting in several films or the fluoroscope, one will not go far wrong in immediately suspecting some type of gall-bladder pathology.

4. Lastly, the ampulla of Vater, when made visible by the retention of barium, in our experience has always been associated with some type of past or present gall-bladder disease. At least, this holds true in all our operated cases.

May I emphasize the point that much of this indirect evidence consists of very *slight* variations from the normal, and unless the roentgenologist through experience becomes familiar with these changes, they often will be entirely overlooked.

Direct evidence when present is, of course, the most dependable for making a positive *x*-ray diagnosis. Unfortunately, however, this type of evidence seems to be found only in a minority of gall-bladder cases. I will not attempt a discussion of gall-stones, but in considering the visible gall-bladder there are one or two points where mistakes in interpretation are commonly made.

1. Not infrequently, a food-filled antrum of the stomach will cause a shadow at times simulating very closely a gall-bladder shadow.

Such a shadow, however, may be differentiated from a true gall-bladder, first by the fact that it is inconstant. Peristaltic waves may alter its shape from time to time. If a second examination is made, taking precaution to have the stomach empty, this shadow will not be found. Furthermore, if the patient is given the barium meal, the clearly defined antrum will be found to correspond exactly with this suspicious shadow. Finally, in cases where the shadow is due to stomach or duodenum, one will usually find a definite line or margin between this shadow and the edge of the liver, whereas with a shadow due to the gall-bladder, we find it apparently fused and a part of the liver shadow.

2. An unusually shaped or placed kidney, or a kidney overlaid by a gas-filled colon may at times simulate a gall-bladder shadow. Precautions should always be taken to identify the right kidney, before designating a suspicious shadow as due to gall-bladder.

3. An unusually shaped edge of the liver may be confused with a gall-bladder. The presence of a Riedel's lobe or an unusually prominent fissure may be the source of confusion.

Again, one finds erroneous interpretations of the ampulla of Vater. One must remember that the ampulla is found on the inner side and close to the second portion of the duodenum, about at the junction of the upper and middle thirds. While it may vary somewhat in size, it is usually smaller than a pea. Congenital diverticula are not uncommon in this region, and should not be confused with a possible ampulla. These congenital diverticula may occur in any portion of the duodenum and may project from any surface. They are usually larger in area than the shadows produced by barium in the ampulla.

In addition to these chances for error in interpretation which can account for some poor results in gall-bladder diagnosis, we must also consider how far faulty technique is to blame for some of our failures.

While the fluoroscope has a very definite place in gall-bladder work and is perhaps indispensable for demonstrating certain types of secondary evidence, still, for consistently successful results, it is of prime and fundamental importance that the radiographic method be employed. Those who habitually use the screen for gastrointestinal diagnosis, perhaps taking an occasional routine film, are at once doomed to failure, if they apply this method to their gall-bladder work.

Of necessity, the fluoroscopic method has to be employed in many of our large hospitals, which accounts, to my mind, for the general lack of enthusiasm with which this work has been taken up in many large institutions.

A persistent use of films with intensifying screens and possibly the Bucky diaphragm is essential for any sort of a demonstration of direct gall-bladder evidence. Furthermore, a barium meal with practically a complete gastrointestinal examination is required to bring out adequately the secondary evidence. And as we have tried to show you, *without* this secondary evidence, the *x*-ray will be of value in only a very small percentage of our gall-bladder cases.

Again, the patient must appear for examination with the gastrointestinal tract empty. Therefore, those who use the double-meal method, seeing the patient for the first time several hours after the barium meal, are at once precluded from successfully using the *x*-ray for gall-bladder diagnoses.

In conclusion, may I remind you that I have attempted to discuss very superficially some of the possible causes of the wide difference of opinion which still seems to exist in regard to this gall-bladder work. I have tried to show you wherein some of us may have been over-enthusiastic in our claims and perhaps have based our conclusions at times on rather weak premises. On the other hand, I have tried to explain why some have failed of success, enumerating some of the common pitfalls which spell defeat in this line of work.

May I assure you that there is no doubt in my mind but what there is, somewhere between the two extremes, a safe and sane ground where honest and careful roentgenologists may successfully employ the *x*-ray in the study of gall-bladder disease, both with satisfaction to their consultants and profit to their patients.

DISCUSSION

Dr. Cole. Dr. Leonard has just given us what seems to be a fair analysis of the value of gall-bladder diagnosis. Having been trained in the office of one considered by some to be over-enthusiastic, it seems to me that he has given an unusually well-balanced opinion of the value of this method of diagnosis.

We can stay at home, we can work hard, and we can see cases and pathology there, but it is only at these meetings that men make up their minds to do things which they have not done before, making radical changes.

In the very first communication which I gave on this subject I stated that we should consider the indirect or secondary evidence first because we believe it of greater value than the direct evidence. In a case that presented itself for a routine examination of the gastrointestinal tract, including the gall-bladder which came with obscure symptoms, if the roentgenograms showed distinctly a group of gall-stones, and there was no indirect evidence of those gall-stones or gall-bladder pathology, I would say that that evidence, that is, the gall-stones, was of far less clinical and surgical significance than another group of cases where there was characteristic indirect evidence, but no stones shown. I will go so far as to say that I believe that in those cases where gall-stones are shown distinctly, where there is no indirect evidence of adhesions, there is not sufficient roentgenological evidence upon which to base a diagnosis of pathological gall-bladder which has surgical significance.

Therefore, it is at such meetings as this that we make up our minds to do things. So far as I am concerned I am through for good and all examining patients solely for direct evidence of gall-stones. If they want an *x*-ray examination solely for the diagnosis of stones, and do not want a complete gastrointestinal examination, they can go to other roentgenologists, but I am through.

We have all seen time and again this pressure deformity on the cap where there is indirect evidence of adhesions which hold the cap in place with the patient in various postures. What Dr. Leonard is talking about is that pressure without adhesions, that deformity of the cap and of the descending duodenum without evidence of any other secondary adhesions. If time proves that this is a valuable and accurate method of basing a diagnosis of pathological gall-bladder, then I say that something new and valuable has been presented at this meeting by one of our own members.

There are, however, pitfalls, in that there are other things in the right hypochondrium which will give that pressure, and these must be differentiated from the gall-bladder. One is the caudate lobe. Pressure of that lobe on the cap might lead to error.

There is only one other point I would like to make about this indirect evidence. If all deformities of the cap which are not ulcers were due to gall-bladder adhesions, the going would be a path of roses, but in many instances we have a veil or membrane, which I have described at previous meetings, which is the "fly in the ointment." You must attempt to differentiate those that are of gall-bladder origin from the congenital veils or membranes.

It is perfectly easy for the surgeon, if he is familiar with the surgical appearance of the veil, to go in there and find it. If the surgeon is intent on its being of gall-bladder origin, he takes the gall-bladder out and sends it to a pathologist; and there is not one pathologist in a hundred who depends for his salary on the hospital who will not report it as gall-bladder pathology.

Dr. Baetjer. I think Dr. Leonard's paper has been a most constructive one for presentation to the Society. The question emphasized by Drs. Cole and Leonard, of indirect evidence of gall-lbadder infection, that is, the relation of the gastrointestinal tract to the gall-bladder, is extremely important. Up to the present time the whole question has seemed to center about gall-stones, and undue importance was attached to their detection. A great proportion of our diagnosis of gall-bladder infections rested upon the detection of gall-stones. Dr. Leonard has pointed out that the finding of deformity and adhesions of the duodenum is really of more importance than the finding of gall-stones. It seems to me that this is a most logical conclusion to arrive at, and that it will, once and for all, reduce the great importance which heretofore has been attached to the detection of gall-stones. It also seems to me that we will really be giving more aid to the surgeon by telling him of the presence or absence of adhesions. In the same way, after an operation, the question of adhesions is a very important one, and there again, we will be able to render material assistance. It seems to me that we have at last arrived at the true basis for the study of diseases of the gall-bladder.

Dr. Leonard (closing discussion). This is not a reversal of form, as Dr. Baetjer said. It is simply natural progress. We first looked for gall-stones and then we looked for gall-bladder. Now we are looking for secondary changes. The future advance of this work is going to be on secondary changes.

The matter of differentiating the pressure from a gall-bladder and from other things is a question we will not take time to discuss. It is going to be possible to make satisfactory differential diagnoses of these pressure and adhesion deformities.

The matter of an ambitious, enthusiastic pathologist is an important thing. The statement that every person over twenty-three has an abnormal appendix is I think, more or less true of the gall-bladder also.

THE ROENTGENOGRAPHIC STUDY OF THE MUCOSA IN NORMAL AND PATHOLOGICAL STATES

BY RICHARD A. RENDICH, M.D.

Roentgenologist, Bellevue Hospital

NEW YORK CITY

THE Solon advises: "A book should not be judged by its cover." To decided advantage may this dictum be heeded by the roentgenologist, who, to date, in his study of disease of the alimentary tract, has been content to base his conclusions on the changes of contour, consequent to pathological changes of the hollow viscera. These changes are revealed on the mucosa before the deformity of its outline is produced. Therefore, demonstration of the mucosa will offer much valuable information not to be obtained by the contour method, and at an earlier date.

The prime object of this work was the demonstration of the gastric rugae, as an indication of gastritis; this possibility having suggested itself after observing the wide variation in the size and character of these folds, particularly during fluoroscopy. Later, it seemed that such study of the mucosa offered possibilities in demonstrating the earlier changes of the organic lesion and in the more detailed study of those conditions already recognized by the present day routine procedures.

In this work the condition of the gastric mucosa has been studied chiefly through consideration of the rugae. Usually, these folds of mucous membrane arise in the cardia and extend downward towards the pylorus, parallel to the axis of the stomach (Fig. 1); frequently those near the greater curvature are oblique and may cross from the posterior to the anterior wall (Fig. 2). Near the greater curvature also, there is frequently seen a fragmentation of the rugae (Fig. 3), this consisting of a division of the folds into portions, an inch or more in length, which may be very tortuous (Fig. 4). Then too, one fold from the cardia may divide or there may be a fusion of several which have their origin above. Frequently, however, there is tendency towards an orderly arrangement from the cardia towards the pylorus (Fig. 5). The rugae may be equally well formed on the anterior and posterior walls, though frequently those of the former are not nearly as well marked. There appears no common arrangement of these mucosal folds, and a wide variation may be noted in different individuals. Their formation is largely dependent upon the muscularis mucosa and the degree of gastric tonus. These observations tend to prove that no change (active or passive) of the position or shape of the rugae occurs while the stomach is in a non-functioning state (Figs. 6 and 7).

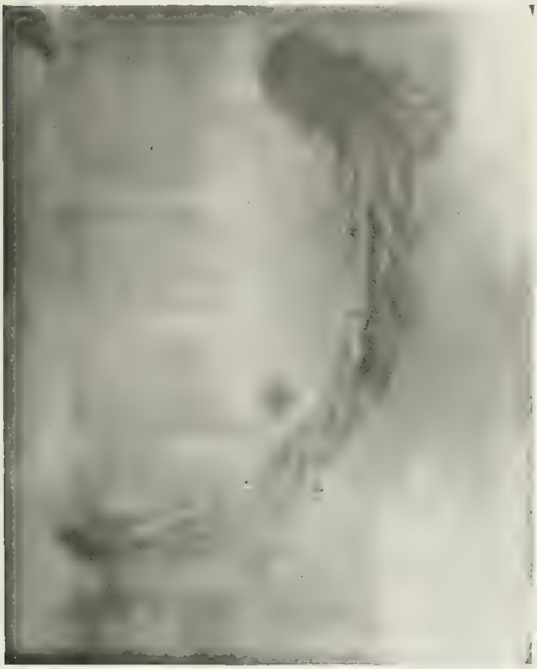


FIG. 1. Roentgenogram of mucosa, demonstrating the normal rugae formation of the posterior wall.

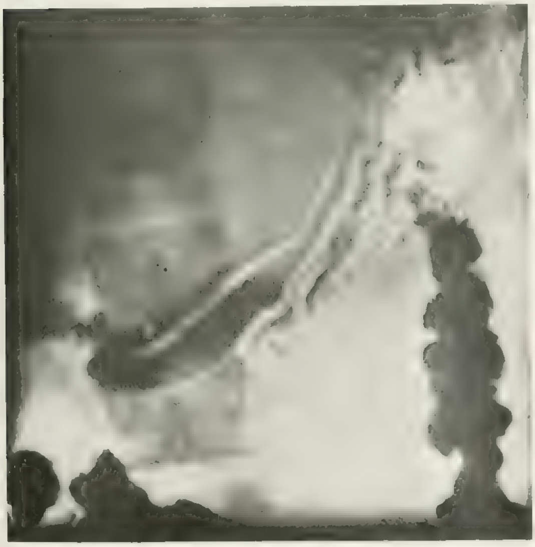


FIG. 2. Roentgenogram of mucosa, demonstrating normal rugae extending obliquely across the posterior wall of the stomach.

In the anatomical specimen, tension tends to obliterate these folds, but on its release they resume their appearance and their former relation. This is due to the fact that the rugae are held in formation by loose connective tissue which permits of their disappearance under pressure. Consequently, this examination is best made on the non-distended stomach.

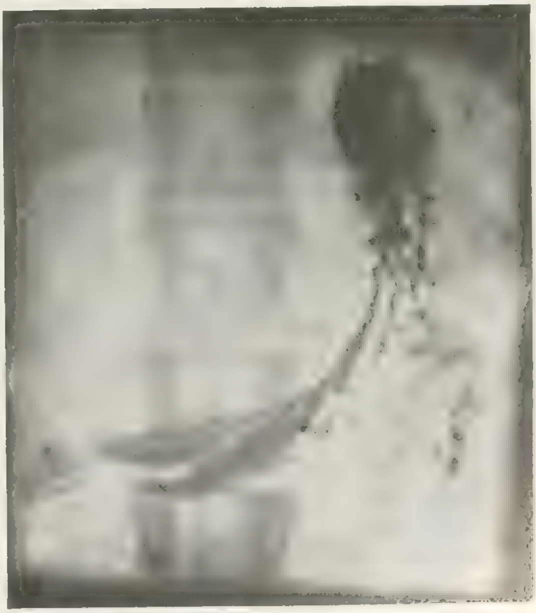


FIG. 3. Roentgenogram of normal mucosa, with irregular rugae formation at greater curvature.

In our work, the rugae of the posterior wall have been studied more completely, as this region is much more frequently the site of abnormalities. As noted roentgenographically, the number of rugae vary with the type of stomach. In the hypotonic type there may be fewer in the vertical than in the horizontal arm, while in the hypertonic variety the number of folds is decreased from the cardia to the pylorus. The orthotonic stomach usually contains about the same number, throughout its length. The rugae, considered normal, as measured on the roentgenogram, (22 in. target film distance) are 2–4 mm. in width. It is to be understood that the foregoing conclusions are the result of roentgenographic demonstration of the mucosa in the living subject; unfortunately, these cannot be compared directly with those noted during autopsy or operation, as the conditions at such times are totally different.

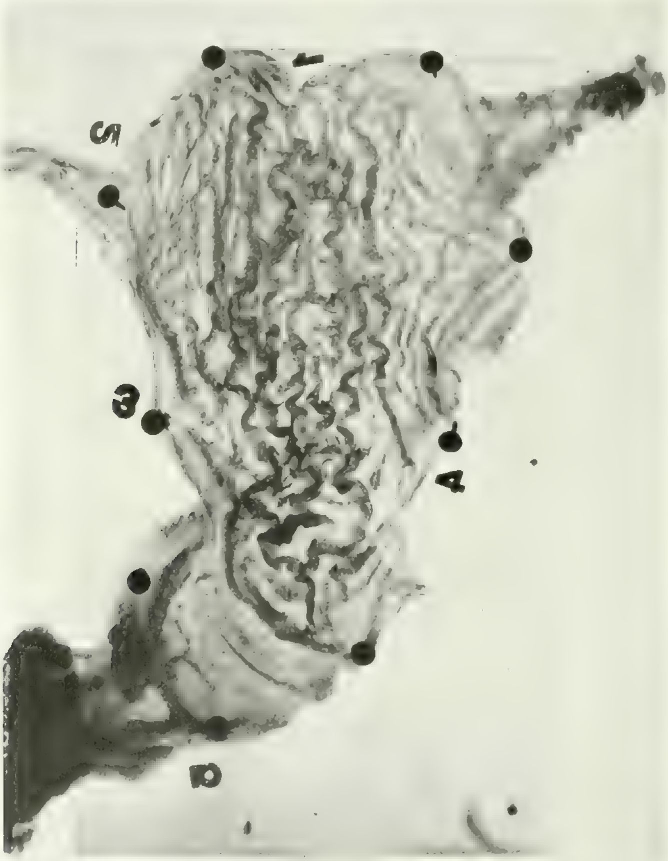


Fig. 4. Roentgenogram of anatomical specimen of stomach, after incision along lesser curvature. (1) Pars cardia. (2) Esophagus. (3–4) Lesser curvature. (5) Pyloric region. Rugae well formed on anterior and posterior walls, tortuous in region of greater curvature.

CONDITIONS PRODUCING VARIATION OF RUGAE

The rugae vary according to the tone of the stomach. When the tone is increased, the surface area of the gastric mucosa is decreased, with the result that its folds are thrown closer together and become more prominent; but when the organ is atonic, the surface area is increased and the mucosa put on stretch to such an extent that the rugae are obliterated.

In hypertrophic gastritis there occurs a cellular infiltration of the mucosa with resultant thickening of this coat; and in the submucosa there occurs a connective tissue hyperplasia. As a result, the rugae are enlarged, and of somewhat irregular formation, and tend to resist obliteration.

The atrophic type of gastritis is associated with a marked thinning of the mucosa and all coats of the stomach wall, consequently is characterized by an absence of rugae formation.

Accompanying the diffuse infiltrative carcinoma, there is a decrease in size of the stomach and an atrophy of the mucosa with disappearance of its folds. Concerning the condition of the mucosa with carcinoma of the stomach, Ewing, in his excellent work "Neoplastic Diseases," states: "A relatively intact mucosa often persists in cancer following ulcer. . . . In some cases an adenocarcinoma is associated with general hypertrophic gastritis. Chronic productive gastritis with atrophy is the most frequent condition, as was early shown by Fenwick. . . . In diffuse carcinoma, the mucosa has been found atrophic, with or without extensive erosion. . . . In diffuse colloid cancer the gelatinous nodules may be widely distributed over the mucosa." In his reference to sclerosing fibrocarcinoma, or Linitis Plastica, he states: "The mucosa is usually thrown into folds or nodular elevations, or it is thin, eroded or ulcerated."

From these statements, then, our findings by radiographic demonstration of the rugae might well be inferred.

Adenocarcinoma is to be recognized by the presence of the mass projecting into the lumen of the stomach, while the rugae would be enlarged or absent, depending upon the presence of hypertrophic or atrophic changes of the mucosa.

The diffuse carcinoma presents a somewhat smooth mucosal surface, with or without evidence of ulceration. This type presents a very characteristic appearance with its stomach often of decreased size, absence of mucosal folds and occasionally, also, evidence of ulceration.

In the scirrhus type, the rugae are again absent and the small oval or rounded nodulations as noted above, are demonstrable.

In gastric ulcer the early pathological process is erosion of the mucosa, which may increase in size and depth to definite crater formation. The former would be represented in this examination by a more or less rounded collection of opaque mixture, surrounded by rugae of perhaps normal formation. At a later stage, definite contracture may occur at the point of ulceration due to the newly-formed cicatricial tissue. In this instance the rugae are noted as radiating in all directions from this point. Gastric ulcer is frequently accompanied by a chronic hypertrophic gastritis, and in that case the rugae are noted to be of increased size.

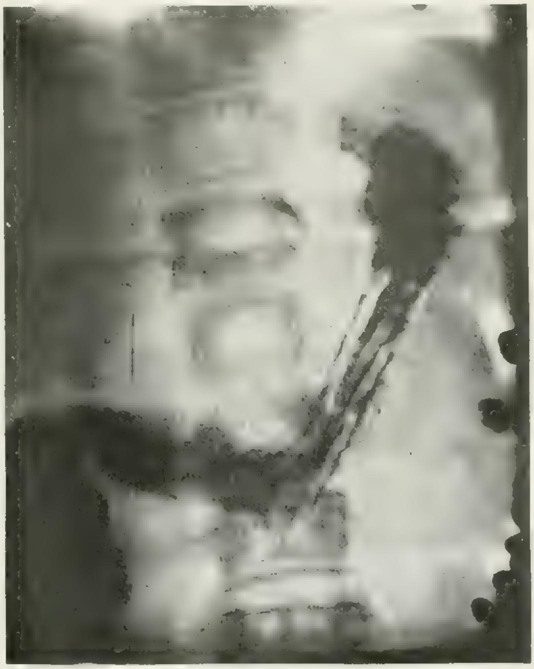


FIG. 5. Roentgenogram of normal mucosa—rugae in orderly formation; those of the pars pylorica not well demonstrated on account of presence of secretion and disturbance by palpation. Small amount in bulbus duodeni.

Having briefly considered the gross pathological changes of the mucosa consequent to the more common gastric lesions, it is at once realized that any information gathered from this study should include:

1. Type of stomach
2. Size of stomach
3. Rugae
    - (*a*) number
    - (*b*) size
    - (*c*) course
    - (*d*) continuity
4. Mucosa
    - (*a*) regular
    - (*b*) irregular
        - eroded
        - nodular

Method. A fifty per cent mucilage of acacia is employed, to which an equal quantity (by volume) of bismuth subcarbonate is added. The official U.S.P. mixture contains 35 per cent acacia, but as usually procured, does not have such content. The mucilage as suggested is readily made by adding directly powdered gum arabic to an equal volume of water; this is stirred well for about five minutes and allowed to stand; after a short time a clear solution will result. When ready for use, equal quantities of bismuth subcarbonate and this special mucilage are well mixed. It is easily administered and while not unpleasant, the taste may be improved by adding a very small quantity of flavoring agent. Honey has been substituted for the mucilage of acacia, but for certain reasons has not served as satisfactorily. The examination is best made in the morning, the patient having had no food since the previous evening and having previously been prepared by catharsis.

Administration. The mixture is best administered while the patient is in a partially recumbent position (about 10° incline) on the fluoroscopic table; a level teaspoonful is given. In this work a table especially designed for examination of the alimentary tract in the horizontal position is used. This consists of a table-top (Fig. 8). Its upper third may be raised to the desired angle, as a simple bed rest. This special table top is not necessary, however, but convenient, as change of position of patient is desirable during this procedure; the table-tilt type of fluoroscope would probably be more advantageous, since a constant target screen distance is maintained with increased angulation. After the mixture has settled in the pars cardia, the back rest is elevated gradually. The patient should not be permitted to raise himself. Observations are made until the rugae are well delineated. Palpation is undesirable, as it produces an irregular distribution of the mixture and changes the conformation of the wall. Exposures are made directly after placing the screened film

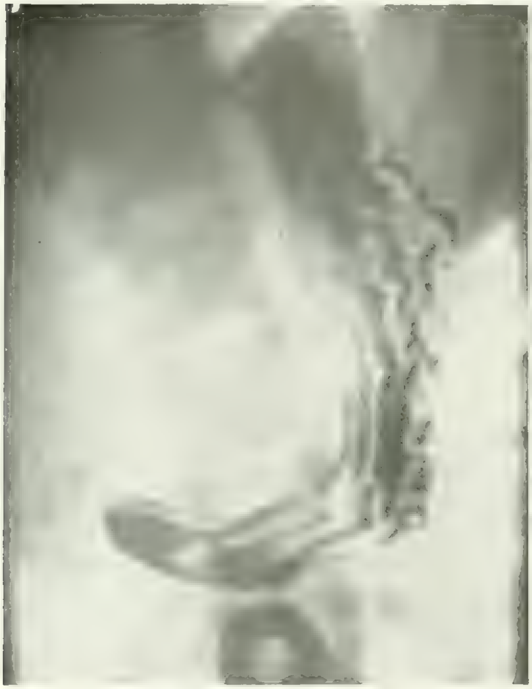


Fig. 6. Roentgenogram of normal mucosa. First exposure.

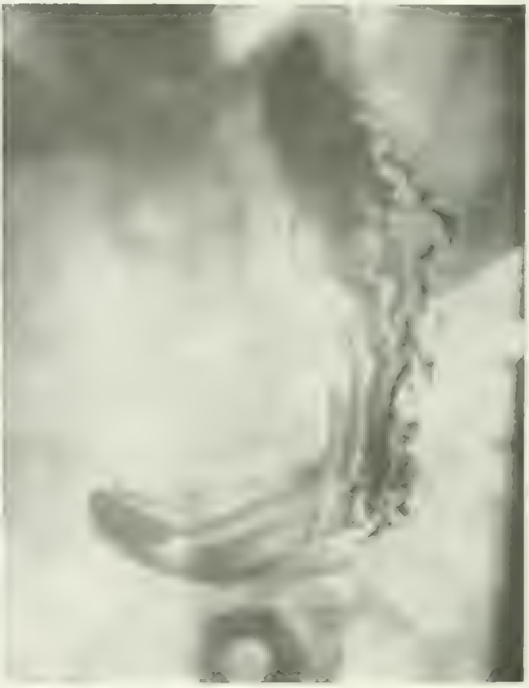


Fig. 7. Same case as in Figure 6, exposure being made about two minutes later, patient having remained absolutely still. No change of relation or position of the rugae has occurred; at this time a larger amount has reached the duodenum.

in position. Stereoscopic plates have also been made in this manner. For demonstration of the anterior wall the procedure is applied with the patient in the prone position.

Certain obstacles may be encountered in the attempt to coat satisfactorily these walls. In ulcer or other cases in which secretion is excessive, it is sometimes necessary to remove same. If a large amount of mucus is suspected it is well also to irrigate with a sodium bicarbonate solution. Another undesirable feature is the deep shelving of the cardiac portion of the stomach, which may, however, be avoided to a large degree by proper preparation.

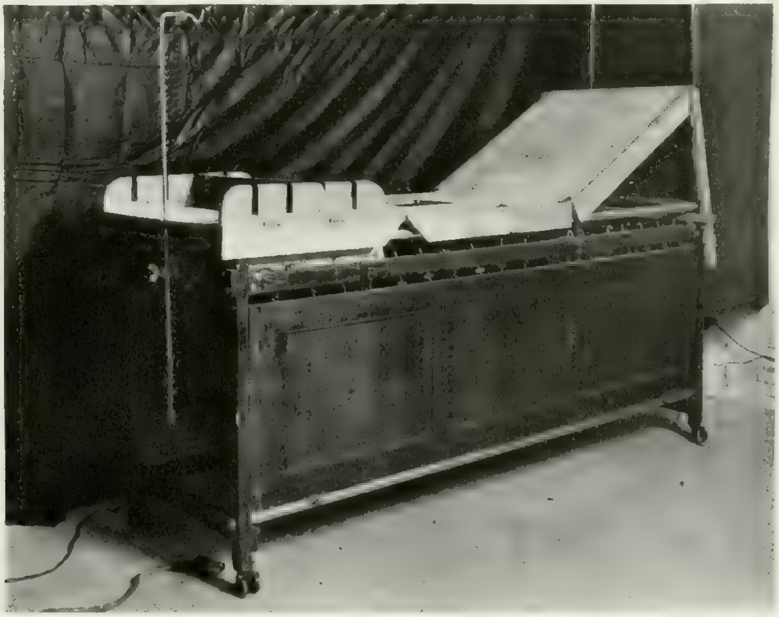


FIG. 8. Wooden table-top as used. Note foot-board to prevent slipping of patient.

Special attention must be given the consistency of the mixture; if too thick, there occurs a tendency to traverse the wall en masse without coating it, and if too thin, it too readily finds its way to the lower pole.

The method of examination as suggested has already served very satisfactorily in:

More detailed and confirmative evidence of gastric ulcer.

More complete study of gastric neoplasm.

Differentiation of extra gastric pressure defects from intrinsic lesions.

The more satisfactory examination of the enterostomized stomach.

The study of gastritis.

Demonstration of the small intestine.

1. *More Detailed and Confirmative Examination of Gastric Ulcer.*

Usually gastric ulcer is readily recognized by the contour method; and the larger its crater the more easily is it demonstrated. There occurs, however, occasionally, a lesion of such small size or so shallow that it may be sighted only momentarily during fluoroscopy. Attempts to demonstrate again this condition may be unsuccessful. Distention of the stomach by a large quantity of mixture obliterates such a deformity completely, and thus the findings are indecisive. A second type of ulceration proving evasive is that confined to the anterior or posterior wall, pars pylorica, without evidence of infiltration or spasm of either curvature.

Radiographic demonstration of the mucosa offers proof conclusive of such ulcers, since the mixture invariably finds its way into the pouch, however shallow, and adheres to this localized area. By this means, we have been able to render a definite diagnosis in an otherwise indeterminate case.

Further, such study affords valuable information concerning the ulcer, which has already been recognized in the usual way. The size of the crater may be more accurately determined, its margins more readily demonstrated as well as the condition of the surrounding mucosa, and the degree of cicatrization. The latter point is distinctly shown by the course of the rugae in the region of the lesion. With such scarring is noted a puckering at the crater with radiation of the surrounding rugae from that point (Figs. 9, 10 and 11).

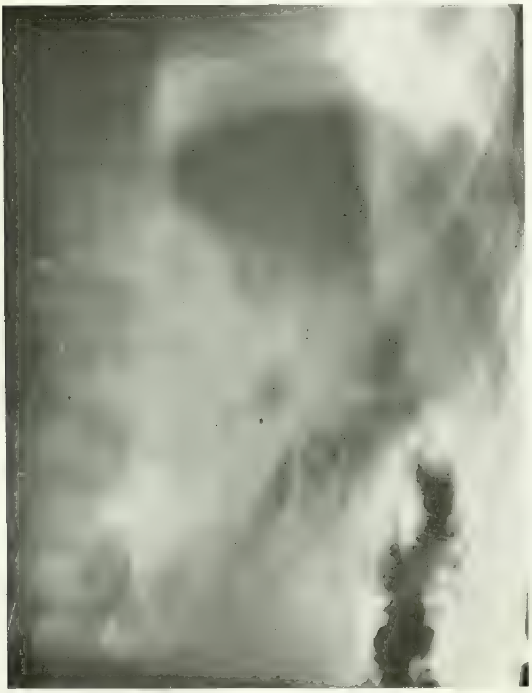


Fig. 9. Gastric ulcer of lesser curvature, demonstrating collection of mixture in crater and rugae radiating from same due to contracture at this point; rugae ill-defined on account of breathing.

If contraction has not occurred the rugae extend as normally (Fig. 13). Again, the rugae accompanying gastric ulcer may be seen to be definitely enlarged, due to the associated hypertrophic gastritis. This method then offers a more complete examination of gastric ulcer and should assist materially in interval study to note the progress of repair during treatment of this condition.

2. *More Complete Study of Gastric Neoplasm.*

The roentgen study of carcinoma of the stomach by the usual method is somewhat limited by our inability to determine accurately the extent of the infiltrative type of lesion. As one might readily infer, this point is more definitely established by observation of the intima. The zone of involvement is recognized by the obliteration of rugae in a relatively small stomach and in certain cases by the irregular nodular appearance of the mucosa (Fig. 14). Such a picture is most striking and not only serves as an indication of extent of involvement, but, more important, offers a definite diagnosis to the less experienced. It may not be amiss to remark that the infiltrative variety of new growth may escape detection, as its early recognition is not always an easy task.

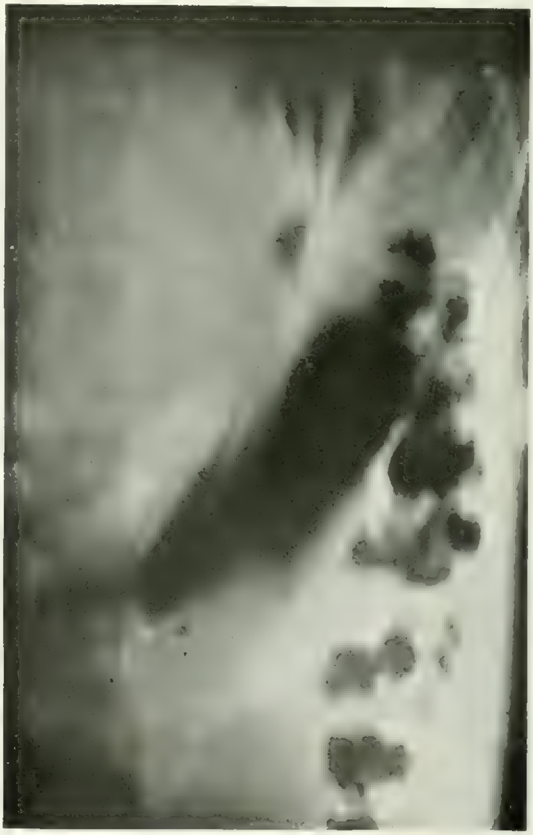


Fig. 10. Lesser curvature ulcer, with cicatrization.

The medullary or fungoid growth ordinarily produces a typical gross defect. Consequently, it is infrequently overlooked, and examination by a special method is rarely necessitated; yet, in the growth of small size, confirmation may be desirable. Such mass is represented by an absence of the mucosal folds in the affected zone, and the encircling of the tumor by the mixture so that it is directly outlined. In the presence of an accompanying atrophic gastritis, the rugae are obliterated.

3. *Differentiation of Extra Gastric Pressure Defect from Intrinsic Lesions.* Not infrequently a regular deformity of one or the other curvatures of the stomach confronts the roentgenologist, and demands a differentiation of pressure defect from an intrinsic lesion. Ordinarily this is easily and satisfactorily accomplished; but in an exceptional instance, the findings may not be conclusive.

From the foregoing description of the normal and pathological mucosa as demonstrated radiographically, one immediately sees the marked contrast between the two cases. In the case of deformed contour resulting from an extragastric pressure defect, the rugae of a normal mucosa are noted, while the characteristic findings of an infiltrated mucosa as described above are seen in the case of intrinsic lesion (Figs. 15 and 16). This single finding at once suffices for a definite conclusion.

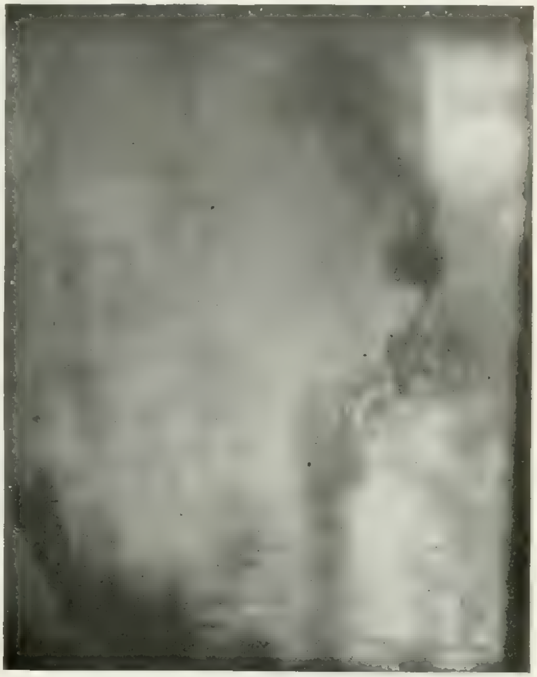


FIG. 11. Ulcer, posterior wall of stomach with less marked contracture. Mixture has passed into jejunum.

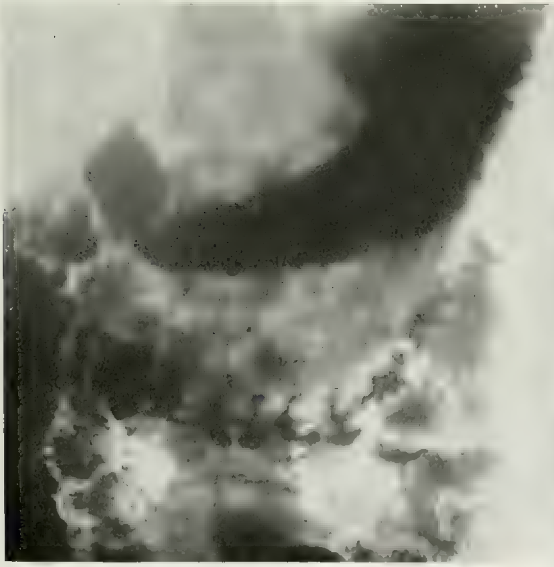


FIG. 12. Examination by "contour" method. Note very small niche of ulcer lesser curvature, pars media.

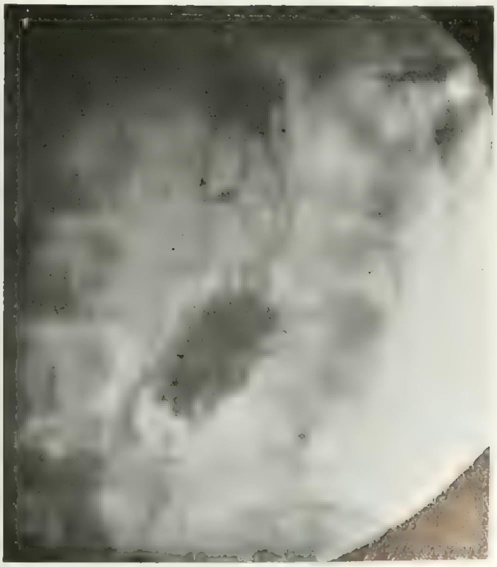


FIG. 13. Same case as in Figure 12, demonstrating ulcer much more satisfactorily; note that radiating rugae are not present.

4. *The More Satisfactory Examination of the Enterostomized Stomach.*

The difficulty encountered in directly demonstrating the stoma by the commonly used method is generally appreciated. Frequently, the evacuation of the liquid through the enterostomy of large size is so rapid as to render its visualization very unsatisfactory; then too, the stoma of high position is frequently obscured by the opaque mixture in the lower pole of the stomach. With the method suggested the mixture descends the posterior wall and in its slow passage through the gastro-enterostomy opening, renders this portion plainly visible (Fig. 17). It thereby reveals the slightest deformity of its contour, and consequently offers a more efficient means for the determination of pathological states of the newly-formed canal and the jejunal loop.

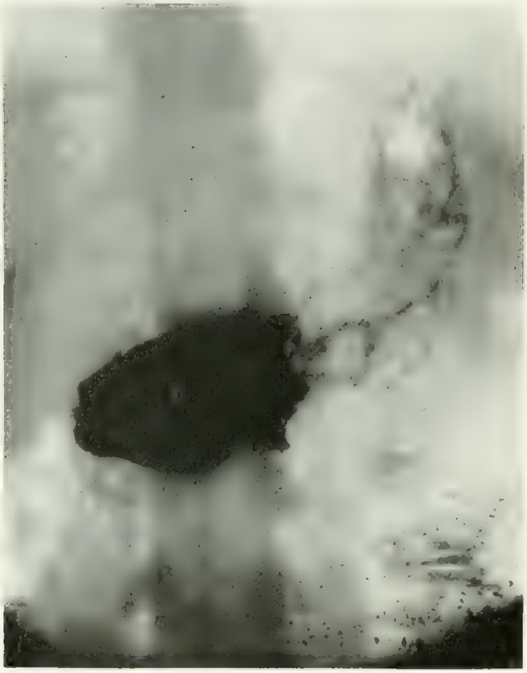


Fig. 14. Mucosal surface of diffuse scirrhus carcinoma of stomach (autopsy); note absence of rugae formation and nodulated appearance of mucosa. Too much mixture had been administered, and insufficient time allowed for the evacuation of excess.

5. *The Study of Gastritis.*

Little attention has been paid to the size of the rugae as an indication of chronic hypertrophic and atrophic gastritis, presumably because these folds vary so widely in different individuals.

In hypertrophic gastritis the mucosa itself is thickened from cellular infiltration and the submucosa presents a hyperplasia of connective tissue elements; these changes tend to produce greater prominence of the mucosal folds, by their increased size and irregular course (Fig. 18). It has been frequently noted radiographically that enlarged rugae accompany organic lesions, particularly ulcers of the stomach, less commonly of the duodenum. The presence of an associated chronic gastritis is generally conceded in these conditions, and it is therefore assumed that such enlargement of the rugae is due to the underlying gastritis.

Marked variation of rugae formation has been noted in cases presenting no other evidence of abnormality. It was best demonstrated in days past in those patients from whom a pronounced alcoholic history was elicited. The association of alcoholism and gastritis is appreciated and for this reason also the enlarged size of the rugae was considered an indication of the hypertrophic changes produced by this chronic irritant. The enlargement and irregularity of the rugae referred to are very distinctive, and by this method contrast with those seen normally. As mentioned, the atrophic type of gastritis presents a marked thinning of the mucous membrane and consequently a decrease of size or complete absence of rugae.

6. *Demonstration of the Small Intestine.*

On account of the rapid passage of the liquid mixture commonly employed through the upper small intestine, study of the jejunum and proximal ileum is rather difficult, but in the method suggested this thicker mixture travels more slowly and tends to coat the walls, thus rendering a satisfactory visualization of them (Fig. 19). Fortunately, organic lesions of the jejunum and upper ileum are rare, but for certain studies one may be desirous of more complete radiographic investigation, and in this event the method suggested offers such an opportunity.

While this work is yet incomplete it is anticipated that study of the mucosa will prove of further advantage in:

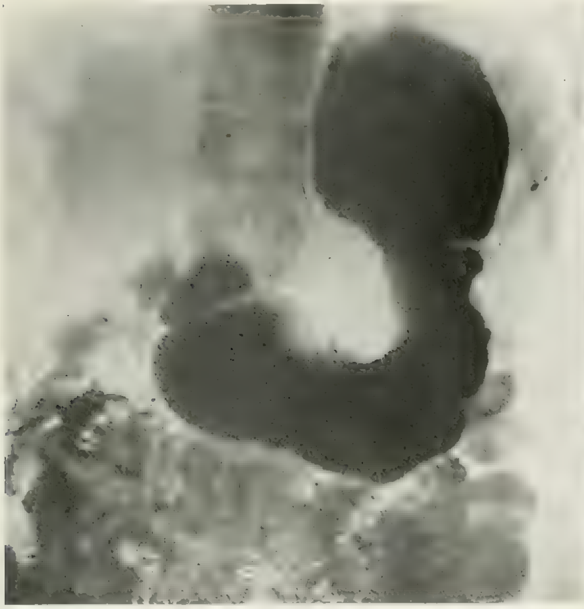


Fig. 15. Roentgenograph after contour method. Deformity of lesser curvature to be differentiated from extra gastric pressure defect. See Figure 16.

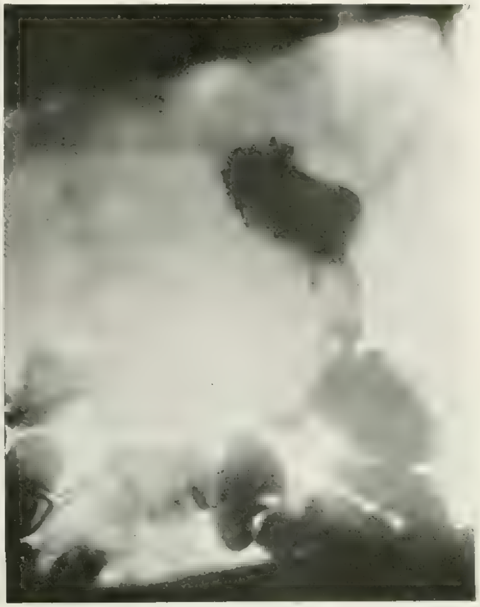


Fig. 16. Same case as in Figure 15. Demonstration of mucosa reveals an intrinsic lesion, a more extensive carcinoma than might be suspected from examination by contour method. The spasm of greater curvature is not noted by this method, as in previous figure.

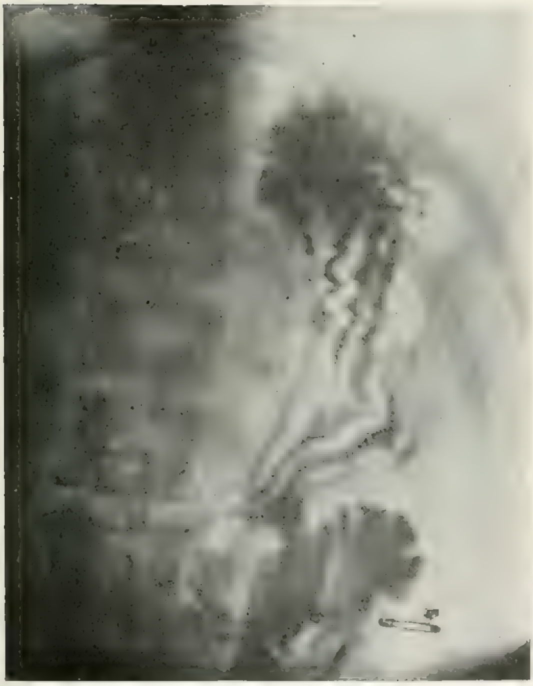


Fig. 17. Special demonstration of gastroenterostomy; evacuation through the newly formed opening was so rapid during the routine examination that the stoma could not be visualized. Note how well-defined is the gastroenterostomy opening by this special method; jejunal loop also satisfactorily demonstrated.

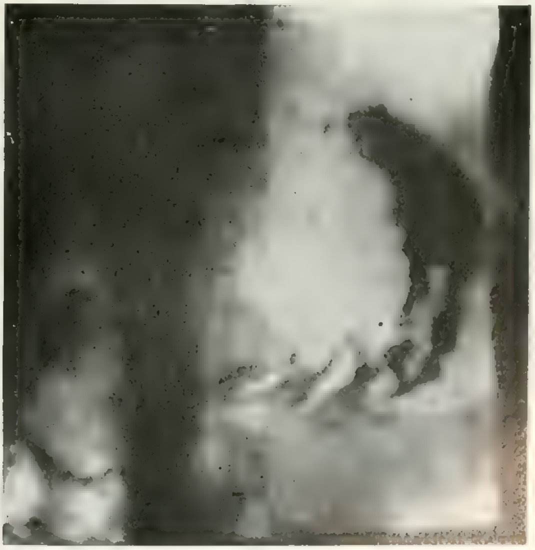


Fig. 18. Mucosal study of case considered to be chronic hypertrophic gastritis; no organic lesion noted. The rugae, in this instance, are not as tortuous as those sometimes noted.

The detection of the mucous erosion.

More definite differentiation of benign and malignant ulceration.

The differentiation of spasm from organic lesion.

The differentiation of duodenal ulcer and periduodenal adhesions.

7. *Detection of Mucous Erosion.*

A simple mucous erosion is occasionally suspected when no satisfactory demonstration of it is afforded by the contour method of examination. The reason for this is obvious, for it cannot be expected to produce a deformity of the gastric contour, as the lesion is confined to the mucosa. Satisfactory demonstration of the mucosa should supply the means by which such erosion could be detected. While a case of this kind has not, thus far, been noted, we have been able to demonstrate much more satisfactorily an ulcer crater so small as to be barely detected by the routine examination (Figs. 12 and 13).

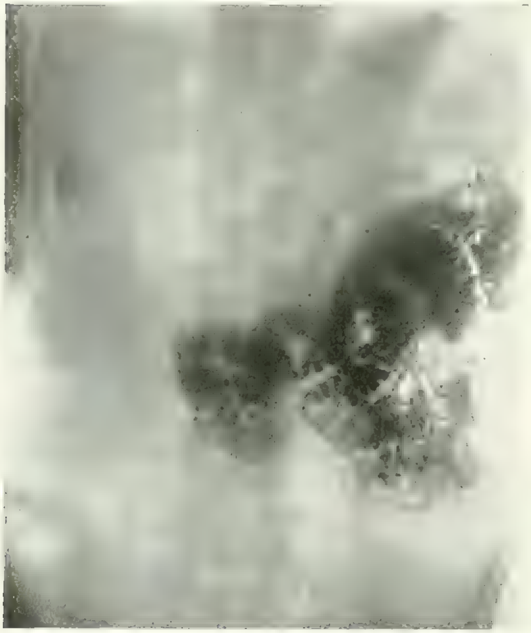


Fig. 19. Demonstration of upper small intestine with aid of special mixture.

8. *Further Differentiation of Benign and Malignant Ulceration.*

No hope is to be offered in the differentiation of the gastric ulcer, which appears macroscopically benign and is found to be microscopically malignant, as this variety possesses no gross qualities by which it can be recognized. The differentiation of ulcerating new growth from a benign ulceration is, however, possible, as their gross characteristics differ. Ulcerating cancer is often surrounded by a zone of infiltration, its crater is usually larger and frequently it has overhanging margins; while the benign ulcer usually has a smaller crater, with less marked infiltration of its borders, and often connective tissue formation with contracture at the ulcer site. The latter is an important feature in this connection as Ewing states: "Secondary ulceration of primary carcinoma rarely produces marked contracture of the wall." The condition of the overhanging ulcer margins referred to might be demonstrated by radiographing the crater in profile after coating the intima with the acacia mixture.

9. *Differentiation of Spasm from Organic Lesion.*

Demonstration of normal rugae such as accompany spasm, at once differentiates it from an organic lesion, and renders needless the antispasmodic for this purpose. Moreover, it appears at present that spastic phenomena are much less common with this examination of the stomach in the resting state, as compared with the distended organ during the routine examination (Figs. 15 and 16). It is hoped that further experimentation will aid in more definitely establishing this important feature.

10. *Differentiation of Duodenal and Periduodenal Adhesions.*

Up to the present, satisfactory work has not been completed in this connection, nor has sufficient data been collected for definite statements, but it seems logical to assume that demonstration of the duodenal mucosa is also practical and the differentiation of organic lesions of the duodenum from spastic and adhesion defects might be accomplished by this method. If this is sustained, one of the great sources of error in the diagnosis of disease of this portion can be eliminated. It is thought that the deformity due to adhesions and spasm of this part are much less marked with this method than when the stomach and duodenum are distended as in the usual examination.

The method described may also serve in the case of the patient who, for one reason or another, might be unable to take or retain the amount of liquid mixture necessary for satisfactory examination by the commonly used method.

It is sincerely hoped that the work suggested will stimulate further endeavors along these lines. Up to the present time, relatively little attention has been accorded the condition of the mucosa. It is, nevertheless, a very important pathological feature, a knowledge of which offers a keen insight into the gross anatomical changes of the hollow viscera.

The radiographic demonstration of such abnormalities appears so characteristic that it should also serve as a corroborative examination, and materially reduce the number of errors of the less experienced workers in the radiological field.

A CASE OF SYPHILIS OF THE STOMACH

BY SAMUEL F. WEITZNER, M.D.

Radiologist, Lebanon Hospital, and Associate Radiologist, Mt. Sinai Hospital

NEW YORK CITY

SYPHILIS of the stomach is generally regarded as an uncommon disease, but the increasing frequency of reports of cases in the literature indicates that it is not quite as uncommon as was formerly supposed. The difficulty in diagnosis lies in establishing a connection between the local gastric lesion and the general disease.

No attempt will be made to discuss gastric syphilis in general or to review its literature. It is desired that the following be considered simply as a case report:

Male, sixty-one years old, a tailor by occupation, was referred for roentgenological examination of the gastrointestinal tract. His chief complaint was cramps in the abdomen, not definitely localized, but slightly worse in the umbilical region. His cramps began eight days before the *x*-ray examination, and had become gradually more severe. He was nauseated and had vomited some bile-stained fluid. There was no blood in the vomitus. There was no fever and the pulse rate was 80 per minute and of good quality.

Past History. The patient denies having had a chancre or any secondary syphilitic manifestations. He has had no gastrointestinal complaints except occasional constipation, until the present time. There was no loss in weight preceding his present illness.

Physical Examination of the abdomen revealed a general rigidity of the abdominal muscles, which the patient could not relax. Satisfactory palpation could not be performed because of this muscular tenseness, but a definite point of tenderness was found about two inches above the umbilicus in the median line. Pupils and knee-jerks were normal. The heart, blood-vessels and lungs showed no unusual physical signs.

Roentgenological Examination, in brief, showed a marked filling defect in the pars media of the stomach. The defect involved both the greater and the lesser curvatures and the lesion had considerably diminished the capacity of the stomach. There was no gastric residue at the end of six hours. Intestinal motility was normal. Conclusions: Large neoplasm in the pars media of the stomach. Because of the large size of the neoplasm with comparatively moderate symptoms and very recent history, syphilis was suspected and a Wassermann test advised.

Subsequent History. At a well-known hospital to which the patient was now taken, a diagnosis of inoperable carcinoma of the stomach was made and the patient returned home. In the meantime, the nausea, vomiting and cramps had ceased. Wassermann tests, now performed, were positive (four plus).

Intensive antisyphilitic treatment was instituted, intravenous arsphenamine, mercury intramuscularly and potassium iodide by mouth. The rapid subsidence of symptoms under the antisyphilitic treatment was very gratifying. Early in the course of treatment improvement was noted, and by the time the entire course had been administered, the patient was clinically well.

He was again referred for examination exactly six months after his first examination, and the stomach was seen to be radiographically normal. The site of the large defect in the pars media now showed normal in contour, peristaltic waves were seen to pass over areas which they had previously skipped, and the normal capacity of the stomach was restored.

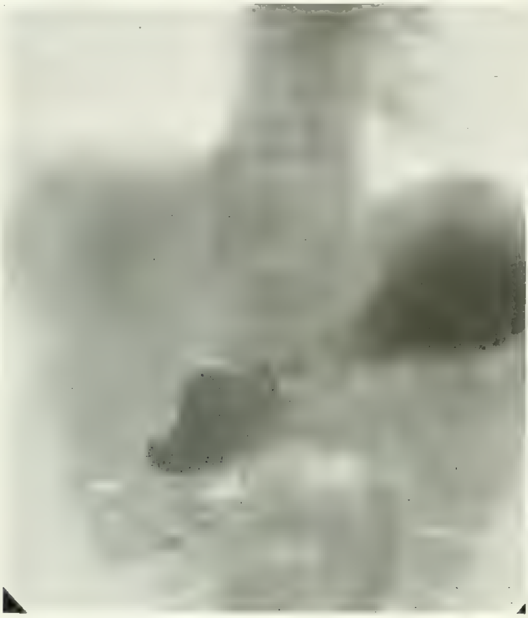


Fig. 1. Filling defect in pars media.

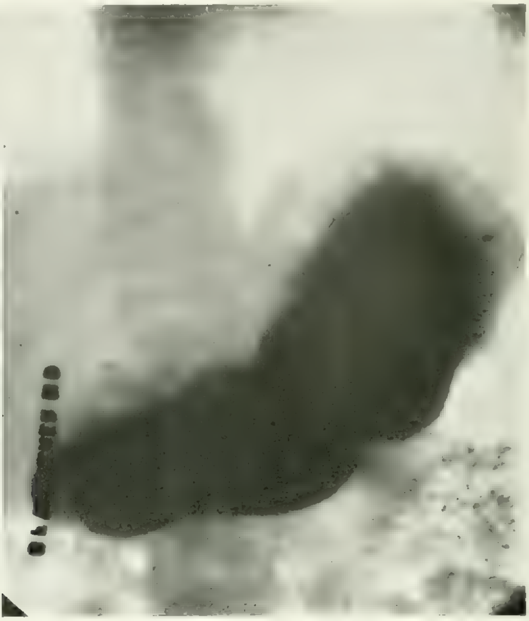


Fig. 2. Six months later, after intensive antisyphilitic treatment. Stomach normal in contour.

SUMMARY

A patient sixty-one years old begins to complain of gastrointestinal symptoms. Roentgenologic examination discloses the presence of a neoplasm of the stomach, which might readily be considered of malignant nature.

Its luetic nature was proven by the four plus Wassermann reaction, and the rapid restoration of the stomach to normal, following active antisyphilitic treatment.

REPORT OF A CASE OF ADENO-PAPILLOMA OF THE STOMACH*

BY I. S. INGBER, M.D.

SAN FRANCISCO, CALIFORNIA

THE general belief is prevalent that all adeno-papillomata of the stomach are of a cancerous nature.

Most of the accumulated information on this subject has emanated from pathological institutes where the studies have been based on specimens found at necropsy in patients who have died of other diseases.

With the advent of the roentgen method of examination of the gastrointestinal tract, we are slowly accumulating additional valuable information about these rare types of gastric tumors.

History of Case

Male, aged sixty; occupation, letter-carrier; married, and father of healthy children.

Family History. Negative.

Past History. Had pneumonia ten years ago. Recovery was good; no complication or sequelae.

Present History. Patient entered hospital because of shortness of breath, cough and swelling of the legs.

Clinical Examination. Sputum showed slight traces of blood. Negative for tuberculosis.

Wassermann. Negative.

Blood Count. Showed a moderate secondary anemia.

Gastric analysis was not done.

Patient was treated for his cough, dyspnea and swollen legs, which promptly improved under rest and medical treatment.

Upon further questioning of the patient after recovery from his actual illness, a story of the gastric disturbances was elicited, which is sufficiently interesting to be recorded in full.

The patient had suffered from so-called dyspepsia for the previous eight or nine years, for which he took numerous medicines, but without relief.

The attacks of dyspepsia were periodical. The patient stated that with the onset of such an attack, he would regurgitate what he described as sweet water. The regurgitation would come on mostly at night between 1 and 2 a.m. He would be awakened out of a sound sleep and run to the bathroom and regurgitate this so-called white, sweetish,w atery liquid. During the vomiting attack, according to the patient's description, his stomach would be tied up into a knot. This feeling would continue for about five minutes after he was through vomiting. His stomach would then relax and the attack would be followed by general abdominal soreness which would last for about one hour. These stomach spells would occasionally occur in the day-time, but only after eating certain kinds of oranges or apples.

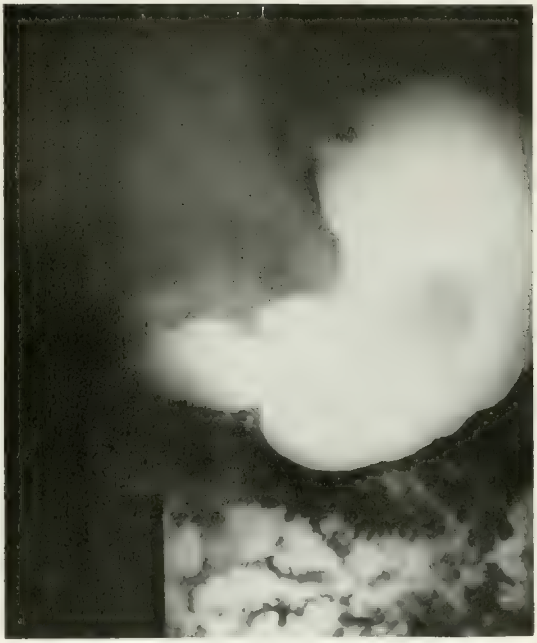


FIG. 1. Round filling defect in pars media showing characteristic distribution of barium mixture in area of defect, due to polypoid character of growth.

There had been no loss of weight in the past ten years.

The roentgen examination by means of the customary barium and buttermilk mixture showed the presence of a round, circumscribed defect in the pars media, situated close to the greater curvature. Both the greater and lesser curvature were intact, there being no break in their continuity. The defect was about 1½ in. in diameter. In the center of the defect were seen small strands of barium.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1922.

There was no delay in gastric motility, the stomach being empty at the six-hour examination.

Roentgen Conclusions. Polypoid growth of the stomach situated in the pars media.

Operation. The tumor was found on the anterior wall of the stomach, and was removed by a partial resection of the anterior wall. The patient made a slow but uneventful recovery.

Pathological Findings. Macroscopically the growth presents the appearance of a cauliflower, the size of a small apple, arising from three slightly separated peduncles.

Vertical sections through the peduncle showed the gastric wall to be normal from the serosa to the muscularis mucosa. The growth arises as a conglomeration of villous processes from the tunica propria, branching fan-like from the peduncle, the larger branches giving off secondary protrusions. The typical glandular structure of the fundus portion of the gastric mucosa is preserved throughout. Vascularization is good. There is no evidence of malignancy.

Diagnosis. Adeno-papilloma of the gastric mucosa, non-malignant.

DIAGNOSIS OF OBSCURE ABDOMINAL LESIONS BY THE ROENTGEN GASTROINTESTINAL EXAMINATION*

BY W. H. DICKSON, M.D., C.M.

Department of Radiology, Toronto General Hospital

TORONTO, CANADA

THIS subject as presented today is not in the form of a finished investigation, but rather a report of a few notes and observations which will, we hope, be added to by other observers. In this way will be built up a method of diagnosis of these conditions as accurate as those of gastric ulcer and gastric cancer today.

In a routine hospital clinic the radiologist is often confronted with a case where the diagnosis is a large interrogative mark; every clinical method had been applied and still the case is undiagnosed. The patient is presented to the radiologist with the statement, "Mass in epigastrium," "Prove presence or absence of malignancy," or "Vague abdominal symptoms."

It was this type of case that gave the impression, "We are not getting all the information present out of our serial plates and screen-work, and we are too easily satisfied with a negative diagnosis of intrinsic intestinal pathology. At the same time we are overlooking information relative to the extra intestinal lesions as accurate as Haudek's niche in ulcer, or the clover-leaf deformity of duodenal ulcer."

The information has been passed only too often with the statement, "Extrinsic pressure," "Extragastric tumor," or some other just as indefinite statement.

We refer to the filling defects and deformity of the stomach, duodenum and colon caused by pancreatitis, carcinomas, cysts of the pancreas, retroperitoneal tumors and other extraintestinal growths.

When an attempt was made to review the literature on the subject, we were impressed by the lack of anything of a definite nature, the articles by Hickey of Ann Arbor and Herrenheiser of Vienna on pancreatic carcinoma being the only ones noted.

The technique is exactly the same as is used in all our routine gastrointestinal examinations. The patient is presented fasting, and 20 oz. of buttermilk with 4 oz. of barium used as the opaque meal. Fluoroscopic examination with palpation of the stomach and duodenum are done in the erect posture and anteroposterior directions. Both diaphragms are investigated for position, shape, and movement. Oblique observation is also done in the erect posture, noting any deviation from normal. If any abnormal condition is noted, a series of six plates is made in the erect posture.

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

The patient is then lowered into the prone position, where further fluoroscopic examination and palpation are done, with a series of ten 6½ × 8½ and two 11 × 14 plates.

The right oblique is then assumed, when screen work is again carried on, and if deemed necessary, a series of five plates is made here.

In the earlier attempts to differentiate these conditions, the pneumoperitoneum method was carried out; but we found that, as far as we were concerned, more information could be obtained by the routine method, with less discomfort and certainly much less risk to the patient.

In making the observations, two definite goals were kept in view: (1) Localization of the anatomical situation of the lesions. (2) Establishment of the pathological entity of the condition if possible. It was found that the localization of the anatomical site was not so difficult; and if that is all we can obtain, it will be of great value to the surgeon, giving him the line of attack, and indicating whether an intra- or extraperitoneal route is advisable; often, indeed, with a conservative surgeon, resigning the case before unnecessary and fruitless exploration has been undertaken.

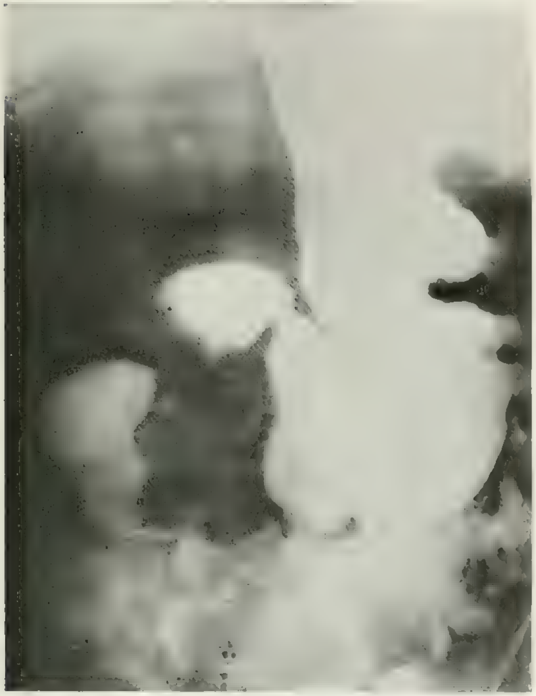


Fig. 1. No. 89056. Roentgenological diagnosis: carcinoma of pancreas. Autopsy: carcinoma of pancreas.

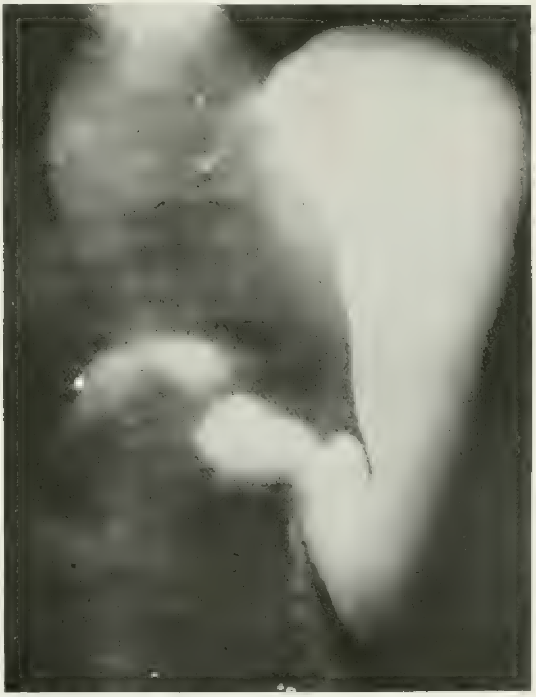


Fig. 2. No. 78621. Roentgenological diagnosis: carcinoma of pancreas. Surgical findings: carcinoma of pancreas.

If we recall the comparatively few organs lying in the upper abdomen, it will be seen how quickly tumor formation will give rise to filling defects in the stomach, duodenum, jejunum and colon.

The liver, pancreas, spleen, kidneys, gall-bladder and retroperitoneal area are all subject to tumefaction independent of any primary focus in the bowel, and by this tumor formation give pressure on the adjacent hollow viscus.

This pressure is usually characteristic, and by it the lesion is localized and often the type can be recognized.

In liver conditions, the involvement most frequently encountered is secondary, due to a primary elsewhere, the primary often being found in the gastrointestinal tract. When the whole organ is enlarged, we get a displacement downward and forward of the hepatic flexure and first portion of the transverse, with a displacement to the left of the caput and pyloric end of the stomach and an approximation of the descending duodenum to the caput.

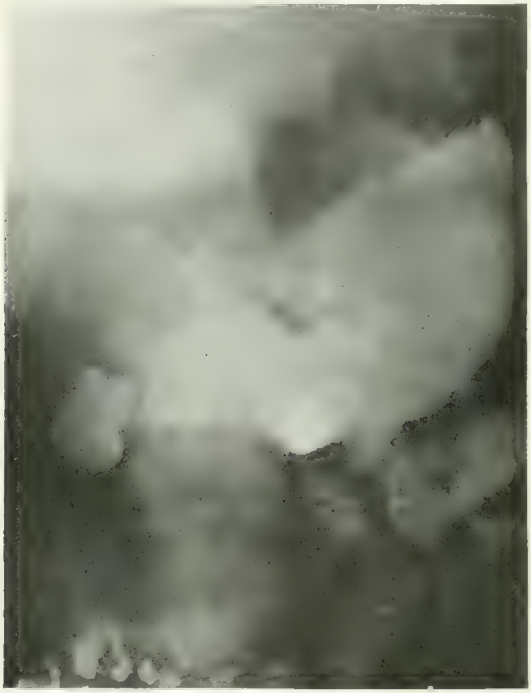


Fig. 3. No. 84075. Roentgenological diagnosis carcinoma of pancreas. Surgical findings: carcinoma of pancreas.

When the middle portion is involved, we get pressure on the lesser curvature of the stomach. Peristalsis is lessened, but not absent. The curvature assumes a crescentic shape. The deformity varies greatly with inspiration and expiration. On palpation gastric rugae can be seen. There is in these cases no change in the descending or transverse duodenum.

Gall-bladder. We have been fortunate enough to have several cases of carcinoma of the gall-bladder where the diagnosis was made from the duodenal deformity, and the extension to the stomach of the growth. All of them were confirmed at operation.

The duodenum is greatly deformed, particularly the second portion. It is not the deformity seen in adhesions of benign gall-bladder disease, but is firm in appearance, irregular in its course, valvulae conniventes are absent and the angulation is always toward the lower and under surface of the liver. When we palpate the involved area, it moves en masse, if it moves at all. In the serial plates, when one is superimposed on the other, the region of the duodenum involved will always fit exactly. In the gall-bladder region, in two cases, we have been able to see the enlarged gall-bladder with irregular outline, which was additional evidence.

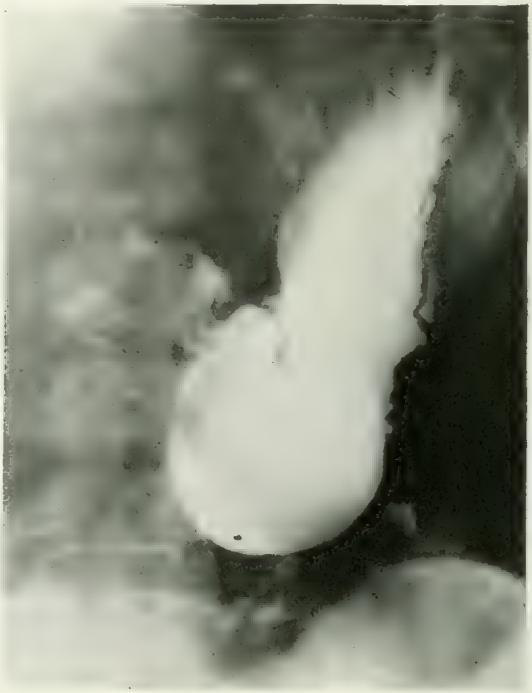


Fig. 4. No. 111024. Roentgenological diagnosis: tumor of pancreas, probably carcinoma. Autopsy: carcinoma of pancreas.

Pancreas. Tumor of the pancreas is probably the easiest of any of the extragastric lesions to place anatomically. However, at times there is great difficulty in arriving at a correct statement as to the type of pathology present. Pancreatitis, cyst, carcinoma, all give filling defects of the stomach and duodenum.

Pancreatitis is usually secondary to a chronic inflammation of gall-bladder,

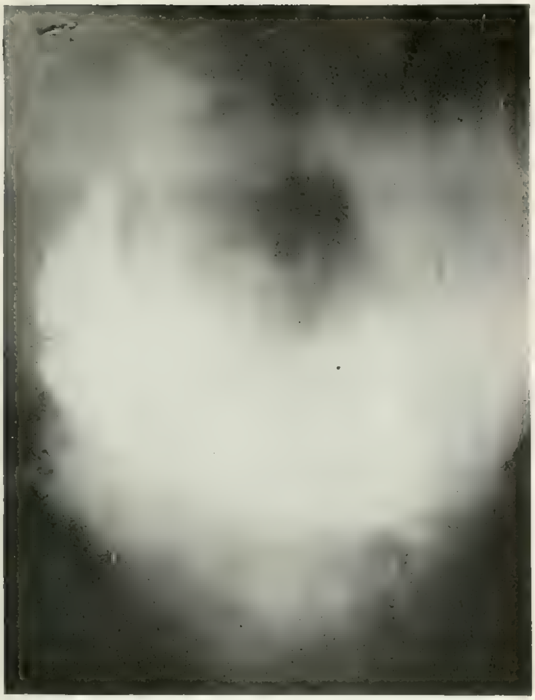


Fig. 5. No. 102390. Roentgenological diagnosis: tumor in tail of pancreas. Surgical findings: carcinoma in tail of pancreas.

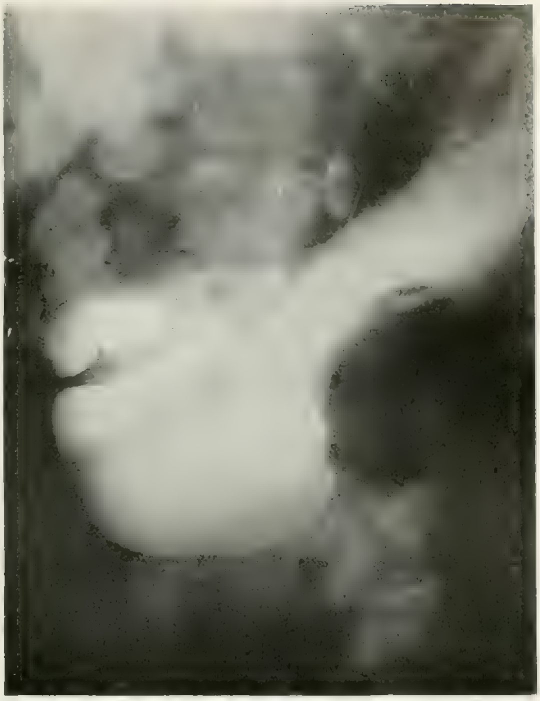


Fig. 6. No. 82406. Roentgenological diagnosis: right and left nephrolithiasis, with left side hydronephrosis. Autopsy: left and right nephrolithiasis with left side hydronephrosis.

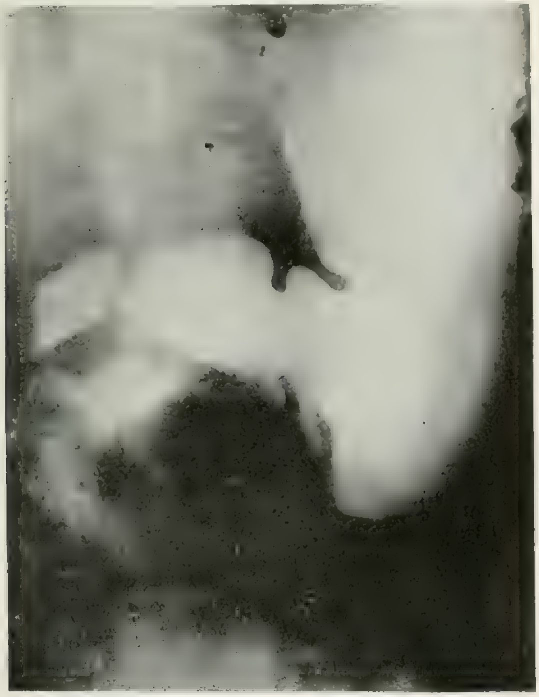


Fig. 7. No. 96673. Roentgenological diagnosis: retroperitoneal tumor in left renal region. Surgical findings: hypernephroma of left kidney.

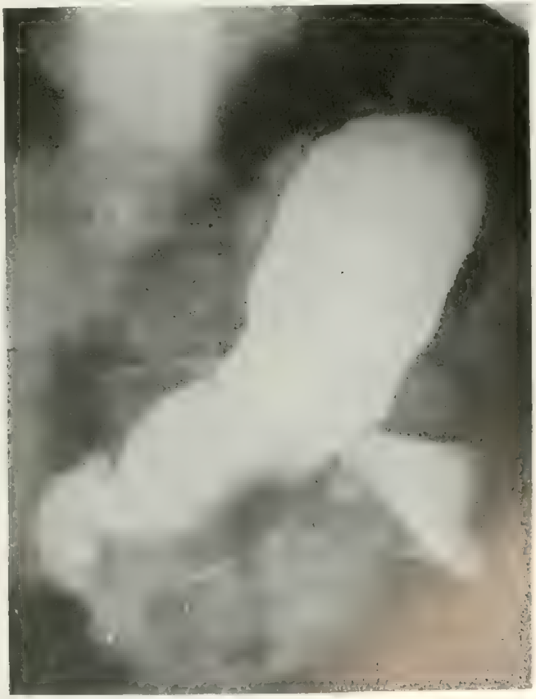


Fig. 8. No. 58973. Roentgenological diagnosis: retroperitoneal tumor on left side with accessory pocket communicating with third portion of duodenum. Surgical findings: retroperitoneal sarcoma with direct extension to and perforation of third portion of duodenum.

appendix, or other abdominal infection, and most frequently follows the chronically infected gall-bladder. On account of this, adhesions are often present and act as guide-posts in the process of elimination. The chief seat of involvement is the head. This gives a slight displacement upwards of the pylorus and presses it slightly to the left. The caput assumes a more or less horizontal position. The descending duodenum describes a larger arch than is usually seen.

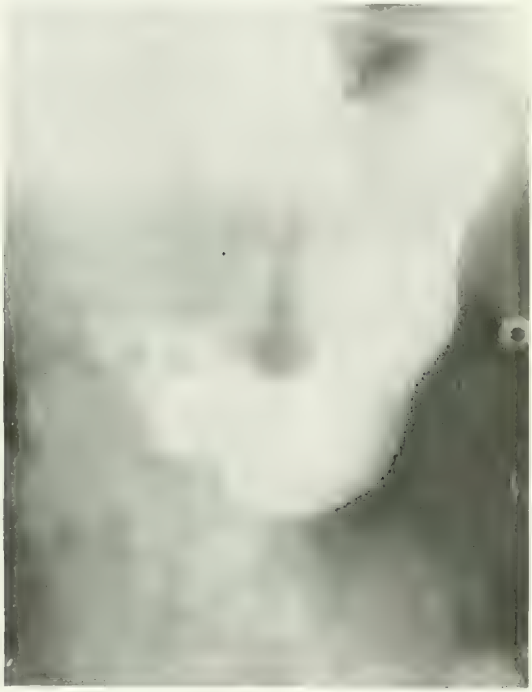


FIG. 9. No. 85982. Roentgenological diagnosis: primary carcinoma of gall-bladder with direct extension to duodenum and pylorus. Surgical findings: carcinoma of gall-bladder extending to duodenum and pylorus—direct extension.

Cyst of the Pancreas. When cysts of the pancreas are present they are recognized only when of sufficient size to give filling defects. They produce a clear-cut outline of pressure in the stomach and duodenum, depending on the site of the cyst in the pancreas. In the head they displace the pylorus to the left, the caput upward and horizontally, the descending duodenum outward and to the right. The outline is smooth. Rugae are present in the stomach and valvulae conniventes in the duodenum. On palpation it can be shown that the tumor mass is free from the stomach and that the mass does not move with respiration.

If situated in the body of the gland, the pars media of the stomach is the site of the filling defect, and this is noted on the greater curvature. The filling defect is small or large, depending on the size of the cyst. It is smooth in appearance, and the rugae of the stomach are seen through it. On palpation of the stomach, it may be lifted away from the tumor mass and the tumor is immobile with respiration. In the erect position, nothing may be seen unless deep palpation is undertaken, the filling defect being most pronounced in the prone position.

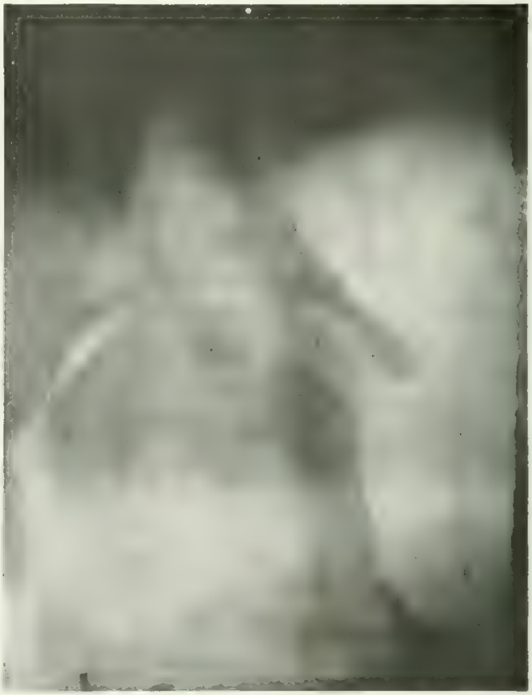


FIG. 10. No. 103448. Roentgenological diagnosis: tumor of head of pancreas. Surgical findings: cyst in head of pancreas.

Cysts of the tail give their filling defect on the lesser curvature. There is little to be seen in the erect posture, only deep palpation bringing out the tumor. It is the prone position here that gives the most information.

Occasionally one will get a pedunculated pancreatic cyst that cannot be localized. In one case the tumor was freely movable and we were of the opinion that it was a mesenteric cyst. At operation it proved to be a pedunculated cyst of the pancreas arising from the anterior surface of the tail.

Carcinoma and Sarcoma of the Pancreas. While we cannot always differentiate the type of neoplasm, we can with a fair degree of certainty state that it is malignant. The situation of the growth in the different regions of the gland give various filling defects. The head of the gland is the position most frequently attacked by malignant growth. On account of the close relationship of the descending duodenum, early deformity occurs and recognition is easier here than in the body or tail. The descending duodenum becomes involved, particularly close to the ampulla of Vater. It is fixed, irregular, the valvulae conniventes are gone and will show areas of constriction and dilatation. When the several plates are superimposed the matching will be perfect in the involved area. This appearance may be present in several places with healthy bowel between, or a single elongated area may exist. As the disease progresses, the pylorus is displaced to the left.

When the neoplasm is situated in the body of the gland the deformity is very like that caused by cystic disease, with this exception: that the transverse duodenum shows evidence of pressure and loss of valvulae conniventes, which is not found with simple cyst, and the pressure outline in the stomach is irregular.

When the tail is involved the deformity is noted on the lesser curvature. An irregular filling defect is seen, which on palpation can be increased or lessened and does not move on respiration; at the same time the rugae of the stomach are present.

Spleen. Tumors of the spleen are easily recognized by the deformity they give in the barium-filled stomach and by the deformity of the splenic flexure with the barium enema. The enlarged organ with its smooth, even contour may be seen displacing the stomach to the right with the greatest pressure near the fundus, giving the stomach an atypical hour-glass appearance. The splenic flexure is displaced downward, and the lower pole of the organ may be outlined by the latter part of the transverse and the splenic flexure.

Unfortunately, various types of splenic tumor give the same radiological appearance and the etiology of the tumor has to be arrived at by other methods of examination. In cases of tuberculosis of the spleen the calcified plaques often are of aid in the correct diagnosis. We were fortunate enough to have this present in three cases.

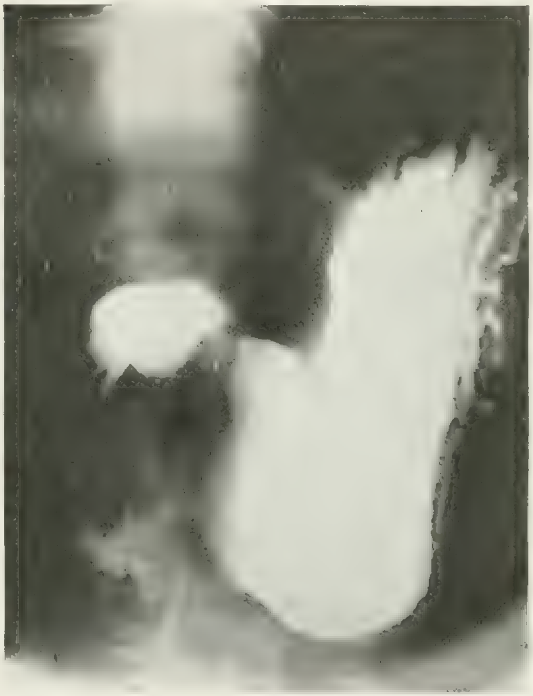


Fig. 11. No. 85691. Roentgenological diagnosis: tumor of head of pancreas involving duodenum. Autopsy: sarcoma of pancreas.

Kidney Tumors, when of sufficient size give very definite displacement of the duodenum, stomach, and jejunum.

When the tumor is present in the right kidney, the stomach, particularly the caput and pylorus, is displaced forward and to the left. The descending duodenum is pushed forward and approaches the midline of the body. In advanced cases the stomach in the anteroposterior position has the appearance usually seen when visualized in the lateral direction and vice versa. The hepatic flexure and ascending colon are displaced forward and to the right. In stereoscopic plates these portions may be seen outlining the growth and anterior to it.

In tumors of the left kidney the stomach is displaced upward and forward with pressure on the greater curvature. The duodenal jejunal juncture is pushed forward and toward the mid-line or over it, and the descending colon is displaced to the left and in the stereoscopic plates is seen anterior to the tumor.

Retroperitoneal growth. Retroperitoneal sarcomas frequently present themselves in a general clinic. Radiologically they give filling defects not unlike those of kidney tumors, but as a rule are more irregular. Good Bucky stereoscopic plates are of great value here as they help to give the outline of the normal kidney and so aid in a differential diagnosis.

Lymphosarcomas, mesenteric cysts, pedunculated cysts of the pancreas give filling defects in the small bowel or colon, but unfortunately do not give any characteristic deformity at present. We have to be satisfied in these cases with the statement that the tumor is of extra intestinal origin, the diagnosis being made at the operating table or in the autopsy room.

DISCUSSION

Dr. Pfahler. During December I had the privilege of visiting Dr. Dickson in his laboratory at the Toronto General Hospital. He spent about two hours explaining some of these cases he has shown you today. He took a great deal more time on the individual cases to tell how he arrived at his conclusions.

I am quite sure that you think he is a very good guesser, but let me tell you briefly that it means a lot of hard work in each individual case.

I think if we all do a little more studying when something unusual presents itself, we will make more of these brilliant diagnoses and also increase our accuracy.

There was one case—the last one shown—which reminds me of another point. During the past summer I had the privilege of visiting Dr. Ake Akerlund in Stockholm. I think most of us have the idea that perforating duodenal ulcer is rare. Dr. Akerlund told me that he had recognized over 300. He showed me at least 50 within the very short time I was there, but he gets them by just such manipulation (compression) and most careful study, as Dr. Dickson has just shown you. As some of you know, Dr. Åkerlund has written a book on duodenal ulcer. I think it a very excellent one.

Another point that occurs to me in connection with Dr. Dickson's demonstration is with special reference to the large stone in the kidney. I believe that if in all instances we will make a preliminary Potter-Bucky diaphragm plate of the entire abdomen, we will arrive at many diagnoses that will at least give us some clearness with regard to the kidneys, liver and spleen that otherwise might be overlooked. In our practice, as a routine, we make the Potter-Bucky diaphragm film on every case. I am one of those enthusiasts Dr. Leonard spoke of this morning, in gall-bladder diagnosis.

With regard to these other studies made by Dr. Dickson, I think we owe him a debt of gratitude for calling attention to the many variations, especially those of tumors of the pancreas. He has shown us, or at least indicated that he sees a great many. You will have to bear in mind that they are probably no more frequent in Toronto than they are elsewhere, but Dr. Dickson spends most of his day working on gastrointestinal cases. He sees a great number, but probably in proportion no greater number than we see. Therefore, in closing I can simply urge thoroughness and increased work to accomplish the results Dr. Dickson has shown us.

X-RAY DIAGNOSIS OF UNUSUAL LARYNGOTRACHEAL ESOPHAGEAL CONDITIONS AND DISEASES

BY SAMUEL IGLAUER, M.D.

CINCINNATI, OHIO

WITH the perfection in the technique of esophagoscopy, there may be a tendency to overlook the value and importance of the *x*-ray diagnosis of esophageal lesions. The information obtained by the latter method is often a great aid to the esophagoscopist, and is of great value (1) in determining the functional activity of the esophagus with the fluoroscope, (2) in getting the static condition of the esophageal lesion (3) as an aid to the introduction and fixation of appliances within the lumen of the esophagus or larynx.

Careful *x*-ray study of the esophagus will often reveal some unexpected and astounding conditions. I should like to cite a series of cases to illustrate these unusual findings.

OPEN SAFETY PIN, POINTING DOWNWARD

CASE I. That of a safety pin in the esophagus of an eight-months-old infant. While "changing" the child, the mother, a physician's wife, missed the pin at 1 o'clock in the morning, and told her husband that the child had swallowed the pin. He was inclined to doubt it, but the child was brought to the city and *x*-rayed by Dr. Doughty, who was much surprised to find the pin with the point down, lodged in the lower third of the esophagus. At 6 p.m., of the same day, upon introducing the esophagoscope, curds of milk were found in the lower esophagus. Upon withdrawing the tube, the patient regurgitated the curds and the pin, which fell upon the floor. In this case, the *x*-ray showed the pin pointed downward, in what is supposed to be an impossible position. Two explanations of this condition have been offered. One is that the pin may be swallowed closed and may open in the esophagus, and the other is that the pin may reach the stomach open, and in the subsequent act of vomiting may lodge in the esophagus with the point downward. It is difficult to conceive that either of these explanations is more simple than that a patient may occasionally swallow a pin with the point downward. In this particular case, the parents are certain that the pin was open when swallowed and that there was no vomiting after the pin had been swallowed. The pin was one inch long, and had a sharp point, which one would naturally believe would stick in the mucosa. Should a similar case occur with the same *x*-ray findings, one might consider the advisability of giving the patient an emetic and thus recovering the pin without resorting to esophagoscopy.

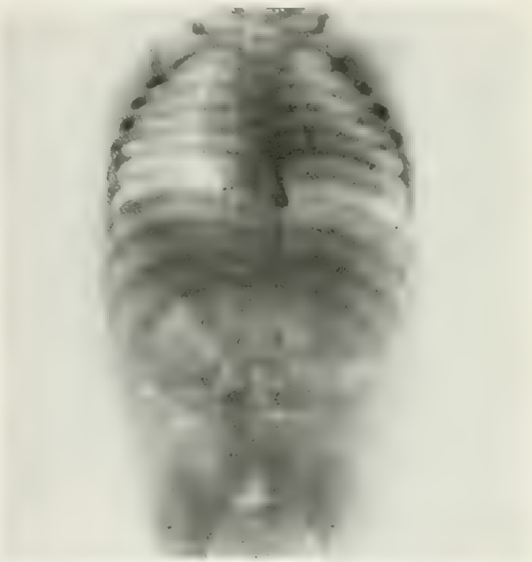


FIG. 1. Open safety pin in the esophagus, with the point downward.

NON-OPAQUE (X-RAY) FOREIGN BODIES IN THE ESOPHAGUS

The esophagus may be partially obstructed by a substance translucent to the *x*-ray. In such cases the diagnosis of the presence of a foreign body is often attended with some difficulty. I should like to cite three cases illustrating this subject.

CASE II. Female, aged fifty-eight, gives the interesting history that when she was a child she was found upon the ground, unconscious, with a pool of blood issuing from her mouth and a dead lizard lying in the blood. Her physician and family allowed her to grow up with the belief that she had been bitten by the lizard, which caused a hemorrhage. She gives a history of having had a persistent purulent expectoration all her life until within the last few months. She stated that she frequently had some difficulty in swallowing, but that she usually managed to get the food either down or up. Her present trouble occurred two days before I saw her. While eating some ham she suddenly was unable to swallow any more food. *X*-ray examination of the esophagus by Dr. Doughty was as follows:

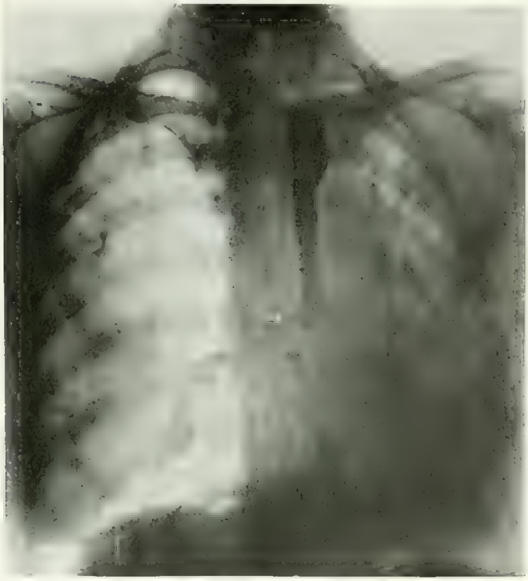


FIG. 2. Angulated esophagus obstructed by non-opaque foreign body.

"There is a rather definite obstruction opposite the seventh dorsal vertebra. This obstruction shows a slight dilatation at the immediate point, but there is shown no definite dilatation from there up. The characteristic marked thinning, just below, usually seen in these obstructive cases due to a malignant type of growth, is not shown.

"In the stereoscopic chest films, the entire left side is shown to be slightly fibrous. The heart and mediastinal shadows are shown to be to the left, as is frequently seen in these old fibrous types.

"Below the point of obstruction, there can be seen about the normal type of lumen of the esophagus, as far as can be made out.

"With the history of this case, it would appear to me that there is some limitation in dilating the esophagus throughout its course, possibly, slightly more at this point. In eating, the food as described by the patient, a few days ago, may have blocked at this point—that is, a rather large portion of the solid food—and which has not, as yet, let go and which does not pass on down; and therefore causes the obstruction. At the seventh dorsal vertebra, there is shown this slightly increased dilated area, which gives this impression."

The diagnosis then was a non-opaque foreign body obstructing the esophagus. I made an additional diagnosis of angulation of the esophagus by the traction of adhesions pulling it toward the left and presenting a very unusual picture. (Dr. P. Armand-Delille, in the *Journal of the American Medical Association* for Feb. 11, 1922, has pointed out that "in 10 of 300 patients with chronic tuberculosis processes in the lungs, the shriveling of tissue and other causes had pulled or pushed the trachea so far to one side that it was liable to be mistaken for a cavity.") Owing to the angulation of the esophagus I anticipated some difficulty in introducing the esophagoscope, but this did not prove to be the case, and I removed two pieces of partially ossified bone from the obstructed point in the esophagus, which was found to be slightly ulcerated at this point. Without an *x*-ray examination the peculiar distortion and narrowing of the esophagus could not have been determined in advance.

CASE III. Male, aged twenty-five, who, three days before, while eating a veal chop and potatoes had a severe choking spell. There has been marked dysphagia since the accident, and inability to swallow anything but semi-fluids. Dr. Lange reports: "Fluoroscopic observation of the act of swallowing revealed no obstruction to the downward passage of barium suspension, but large opaque capsules lodged in the esophagus about on a level with the first dorsal vertebra. The film shows three capsules lodged above a transparent obstruction which is partly outlined by a coating of barium left from the barium suspension. It seems that the watery suspension of barium passes the obstruction freely, but the capsules do not." In this manner the site, and to a considerable extent the size, of the foreign body, which proved to be a large piece of meat, could be clearly determined.

Case IV. Seen in consultation with Dr. A. Friedlander, is even more interesting. A boy, aged six, swallowed lye two years before we saw him. Since that time he has had more or less difficulty in swallowing. Seventeen days before he was brought to us he told his mother that he had swallowed an orange seed. Since that time he had been unable to retain any food, not even water, and vomited almost immediately after eating. He had lost about 12 lbs. *X*-ray examination by Dr. S. Brown showed that opposite the 9th rib posteriorly there was a marked stenosis of the esophagus with a sausage-like dilatation above, and with the barium trickling through in a very thin stream below this point. Upon close scrutiny it appeared to me that there was a filling defect in the esophagus at the point of constriction, which I ventured to suggest might be due to the presence of the orange seed. The diagnosis then was "Stricture of the esophagus, obstructed by a foreign body, with dilatation above the point of constriction." The foreign body was easily located with the esophagoscope and proved to be an orange seed. *X*-ray examination made a few days after the foreign body had been removed, showed, much to our surprise, that the esophageal pouch above the stricture had disappeared, so that by the *x*-ray examination we were able to state that the patient had had an acute dilatation of the esophagus, (comparable to an acute dilatation of the heart)

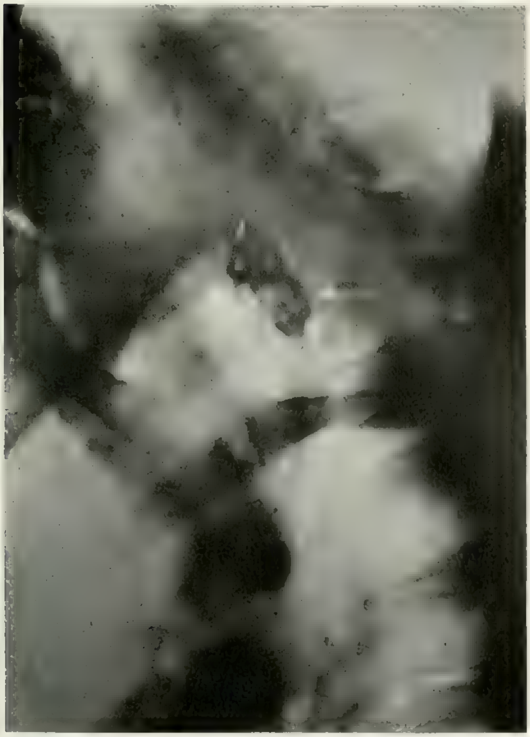


Fig. 3. Three barium capsules lodged above transparent obstruction which is partially outlined by a coating of barium left from the barium suspension.

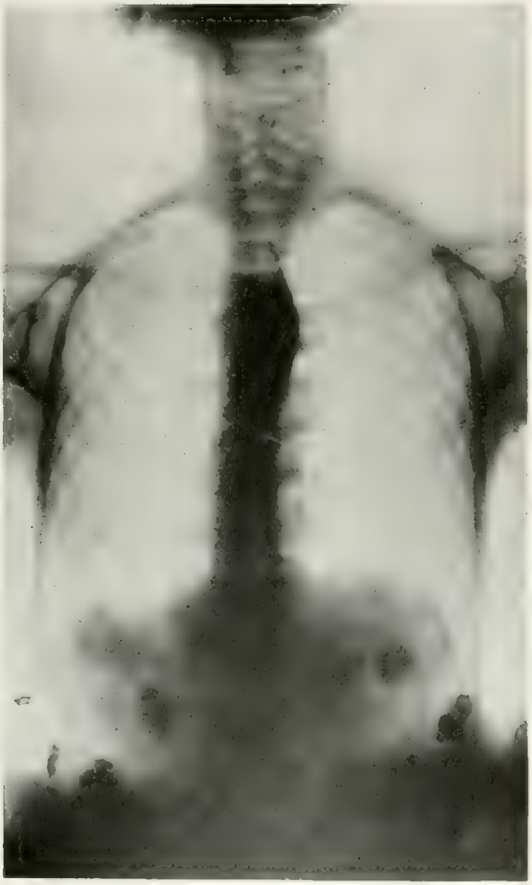


Fig. 4. Lye stricture of the esophagus obstructed by a non-opaque foreign body, with dilatation above point of constriction.

which had disappeared after the obstruction was removed.

Cases II and IV would indicate that the presence of a filling defect in a stenosed esophagus may be due to the presence of a foreign body.

UNEXPECTED X-RAY FINDINGS

Case V. The *x*-ray examination in this case proved to be of great value both to the patient and the physicians. Female, aged seventy-nine, was seen at her residence, in consultation with Dr. List. She stated that she had been having increasing difficulty in swallowing for the last three years, that some of the food would occasionally regurgitate, and that she had lost about 17 lbs. She was bedridden for about a week before I saw her. Owing to her extreme age, the natural inference was that she was suffering with a progressing carcinoma of the esophagus, and it seemed scarcely worth while to subject her to any examination. Nevertheless, we sent her to an *x*-ray laboratory, and upon giving a barium suspension, a large diverticulum of the upper end of the esophagus was discovered. (Dr. Schroeder, and later Dr. Brown.) In order to rule out malignant disease, the esophagoscope was passed into the pouch, but no carcinoma could be demonstrated. Gastrostomy was then performed by Dr. Ransohoff. Since that operation the patient has gained considerably in weight and may live many years as a result of the *x*-ray examination and the operation.[1]

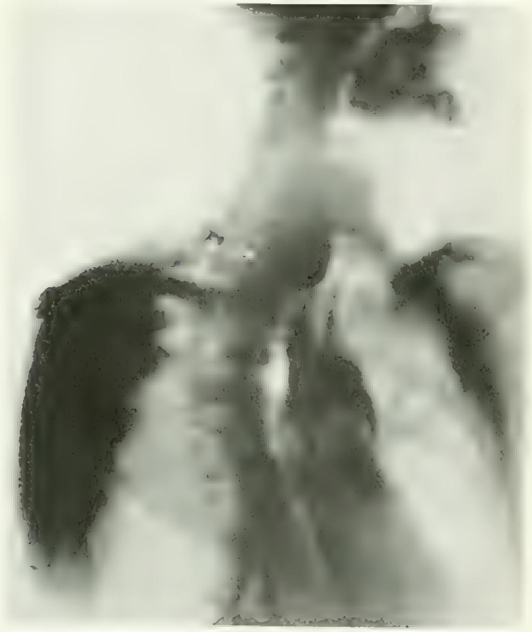


Fig. 5. Esophagus diverticulum, showing barium in the bronchial tree.

An interesting accident occurred with this case. Immediately after the esophagoscopy, during which some cocain was used, the patient was again given barium to swallow, and the *x*-ray picture showed that some of the barium had entered and partially outlined the lower bronchial tree in both lungs. However, the patient expectorated all of this barium suspension, without any damage to the lung structure. This is in line with the experimental insufflation of the bronchi with bismuth, as described by Jackson.

Case VI. The following case shows how the *x*-ray may occasionally make a false diagnosis, and proves that things are not always what they seem. A child was brought to the hospital with a statement that it had swallowed a five-cent piece. *X*-ray examination showed the foreign body in the usual position at the upper end of the esophagus. Upon introducing the esophagoscope, I informed the interne that the patient had six cents in the esophagus, for I could make out the edges of two superimposed coins, one brass and the other nickel. The coins were withdrawn together and proved to be a dime and a penny, so that I was five cents to the good, despite the mistake in the diagnosis.

In cases of cardiospasm, it seems very likely that by inducing pneumoperitoneum and taking an *x*-ray picture of the diaphragm we may occasionally find pathological adhesions of the liver encroaching upon the subdiaphragmatic portion of the esophagus and giving rise to the symptom complex cardiospasm. In one such case, the *x*-ray films show an enormously dilated esophagus with adhesions of the liver to the diaphragm in the area corresponding to the subdiaphragmatic portion of the esophagus.

---

[1] Since the above was written the pouch has been successfully removed by Dr. Ransohoff.

COCCIDIOIDAL GRANULOMA*

BY RAYMOND G. TAYLOR, M.D.

LOS ANGELES, CALIFORNIA

THIS disease, first described in this country by Rixford and Gilchrist, and named and classified by Ophuls, appears to be more common than at first suspected.

Since the attention of the staff of the Los Angeles County Hospital was first drawn to it in 1915, 16 cases have been observed up to May 1, 1921. Five of these, observed prior to October, 1917, were reported in 1919 by Dr. W. B. Bowman, who made the first detailed roentgen report noted in literature; the remaining 11 form the subject matter of this report.

A review of the available literature indicates that the following conclusions have been arrived at by various investigators:

1. The disease is caused by a specific fungus, and affects chiefly adult males of the laborer class.

2. Nothing is known of the natural habitat of the specific organism, other than the human body; however, animals such as guinea pigs, rabbits and monkeys are susceptible to inoculation.

3. There is no direct evidence of contagion, but of the total reported cases (including ours, about 61) the great majority had been, or were, residents of California, and most of these had at some time lived in the San Joaquin Valley. This would suggest the presence of a local causative factor.

4. The infection seems to be acquired from some external source, and the mode of entry is probably through the skin or by inhalation or ingestion. Primary lesions are usually either in the skin or in the lung, and the lesions in general can be classed under the head of infectious granulomata. They resemble those of tuberculosis in every way except in the presence of the specific organism.

5. When the initial lesion appears in the skin it closely simulates the more acute forms of cutaneous tuberculosis and may remain localized for several years. When the initial lesion appears in the respiratory tract, patients are invariably treated as tuberculous. Some time may elapse before lesions appear elsewhere. Apparently in a few cases the initial lesions have been in the joints. Eventually, however, wherever the initial lesion, a general infection occurs, which results fatally. The only exceptions are those few in which the extension of the disease has been limited by amputation.

6. The mode of onset, the clinical course and the pathological picture, as well as the initial lesion, are all strikingly like those of tuberculosis.

7. The disease is probably more common than has been suspected, and it seems quite probable that it occurs more frequently outside of California than has been supposed.

8. The adult forms of the fungus seem likely to produce the chronic lesions, such as nodules, while the immature and sporulating forms produce the acute lesions, such as abscesses and bone necrosis.

In our own cases here reported, we find there were two American Negroes, one Serbian, one Russian and seven Mexicans. There were three children, aged three, seven and nine years. All were males and all adults were laborers except one of the Negroes, who was a cook. All had been residents of California for a period of one year to life, and most of them had been residents at some time of the San Joaquin Valley. Sojourn in the hospital averaged about two months. Seven died in the hospital, two left and outcome is not definitely known, but disease was rapidly progressing and they were considered hopeless when they left; and two (Cases VIII and X) with disease localized in ankle and foot, recovered after amputation. Except for these two latter and Case VII, of which we have no history, and Case IV, of which we have no roentgen record, all showed roentgen or autopsy evidence of pulmonary involvement. The findings of the physical or roentgen examinations were always suggestive of tuberculosis. Five showed physical signs of pulmonary tuberculosis (Cases I, II, VI, IX, XI) on admission, and the sputum of two (Cases I and

---

*Paper submitted with application for membership in The American Roentgen Ray Society, 1922.

II) was positive for tuberculosis. Case I also showed a positive Wassermann. All showed a moderate leucocytosis, (12,000 to 26,000) except Case IX.

Positive diagnosis was made by finding the organism in the tissues, sputa, or pus from sinuses, before operation or death in all except Case VIII, in which organisms were found only after a leg had been amputated and pus from between tarsal bones obtained. Organisms were difficult and frequently impossible to find in the old abscesses and sinuses, and often only found when a new lesion was opened or aspirated. Most of our cases were in a rather advanced stage when received, and several seemed to be of a rather fulminating type and were rapidly fatal. In the advanced cases with multiple lesions it was frequently difficult to get an idea as to which was the primary lesion. Four (Cases II, VII, IX and X) apparently showed the first suspicious lesion about the ankle or foot. However no history of trauma was obtained in these cases.

Most of the localized abscesses were not red or particularly painful until after rupture, or incision and drainage, or involvement of contiguous bone. The development of large subcutaneous abscesses seemed, as a rule, to indicate a generalized infection that was invariably rapidly fatal. Most of the bone lesions appeared to be preceded by either a local skin lesion or a subcutaneous abscess. These abscesses frequently matured and broke down before any demonstrable lesion could be shown in the adjacent bone by roentgenograms.

Definite roentgen evidence of periosteal proliferation was noted in four cases (Cases III, VI, VII and VIII). That in Case III was especially marked. So far as we know, this is the first time this condition has been observed.

A very definite impression was gained that the destructive process in the bones, as shown by the roentgenograms, was, as a general rule, marked by an intensity and rapidity of development not often noted in tuberculosis, a week frequently showing a marked degree of advancement in the lesion. At autopsy the gross bone infiltration and destruction is invariably found to be considerably more extensive than would be suspected from the roentgenograms.

So far, we have been unable to observe any constant feature shown by roentgenograms which is peculiar to this disease and which will definitely differentiate it from bone tuberculosis. The fulminating type of the destructive process and the existence of a proliferative process in a rather unusual proportion of the cases is suggestive, but not by any means constant, as is also the occurrence of the disease in a rather larger proportion of adults than is usually found in bone tuberculosis.

No portion of the skeleton or particular portion of the individual bones seems to be immune. In this series, lesions were found in practically all the long bones except the femur—in the ilium, skull, ribs and spine. Joints, epiphyses and diaphyses show involvement, sometimes collectively and often individually.

For the last two years any patient presenting the rather characteristic skin lesions, soft tissue abscesses or persistent discharging sinuses has been under suspicion by the staff in the diagnostic wards of the hospital. Also during this time, in the roentgen laboratory, it has been our custom to suggest coccidioidal granuloma in lesions which appeared to be bone tuberculosis, which showed proliferation or gave the impression of an unusually acute destructive process. In this way we believe neither the staff nor ourselves have missed a correct ultimate diagnosis. However, we must confess that we have, on several occasions, suggested coccidioidal granuloma in cases that proved to be purely tuberculous.

CASE REPORTS

CASE I. Male, Negro, aged forty-four, laborer. Entered hospital Feb. 5, 1919. Died June 7, 1919. Resident eight years in county and state.

Pain and swelling in back for one month. Has bulging mass at edge left quadratus lumborum muscle.

Roentgen Examination. Chest (Fig. 1). Evidence of old tuberculosis both upper lobes. Lumbar spine, A. P. views only. (Fig. 2.) Rather marked lipping and spurs on the bodies, and some irregularities in the lateral borders on the left of the second, third and fourth. Injection of sinus with bismuth paste shows a large irregular cavity lying along the left border of the spine and over superior portion of the ilium.

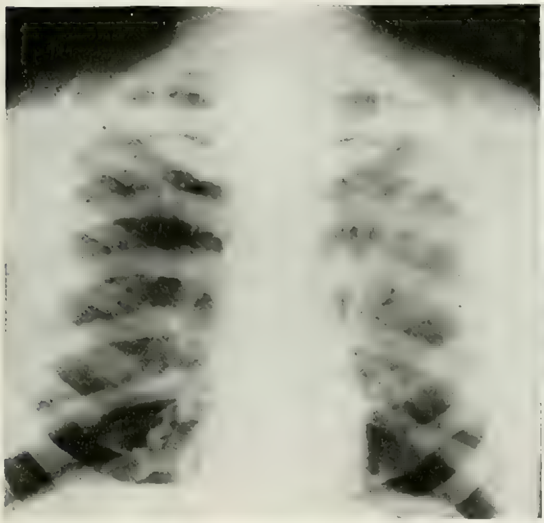


Fig. 1. Case I. Sputum was positive for tuberculosis also.

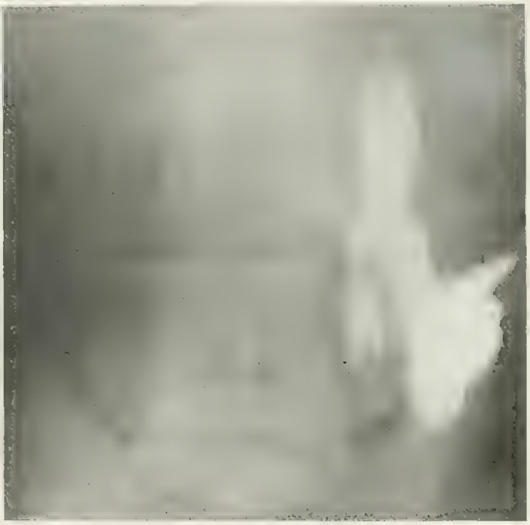


Fig. 2. Case I. Specific organism was recovered from pus from this sinus. Injected with bismuth paste.

Case II. Male, Serbian, aged thirty-four, laborer. Entered hospital March 18, 1919. Died May 27, 1919. Resident in county nine months; in state three years.

Has been in tuberculosis sanatorium for several months; admitted to hospital from there with multiple skin lesions (30) on arms, wrist, legs, trunk and scalp, varying in size from papule to walnut. Ankle swollen over inner surface: fluctuates but not red or painful. About one-half the skin lesions are broken down, have ragged undermined edges, yellowish scabs, and exude a thick yellowish pus.

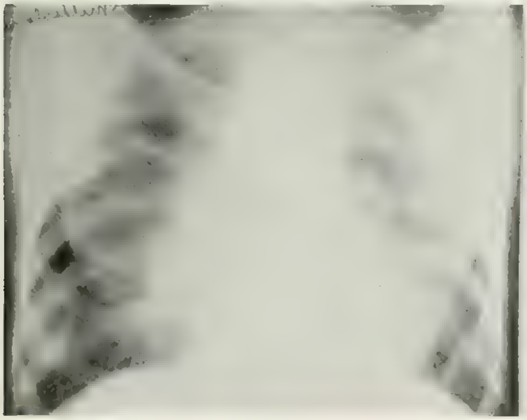


Fig. 3. Case II. Sputum was positive for tuberculosis also.

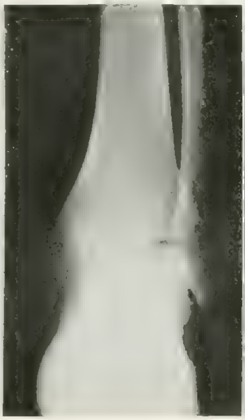


Fig. 4. Case II. Probable primary lesion in internal malleolus.

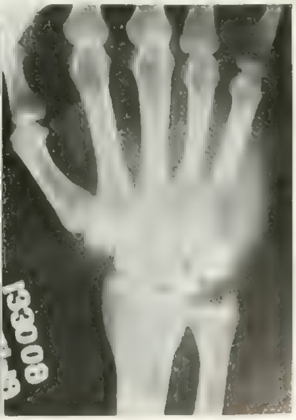


Fig. 5. Case II. Note soft tissue density about lesion in metacarpal.

Autopsy. Under lesions of scalp were several areas of invasion of skull down to dura. Dura not invaded. Miliary lesions (coccidioidal granuloma) of kidneys and adrenals. Caseation and necrosis upper lobe left lung.

Roentgen Examination. Chest. There appears to be a tuberculosis of both lungs and a marked widening of the mediastinal shadow (Fig. 3). Right ankle shows necrosis of the internal malleolus (Fig. 4). Left hand and wrist, a localized but marked destructive process in the proximal end of the fifth metacarpal. The carpal bones apparently not involved (Fig. 5).

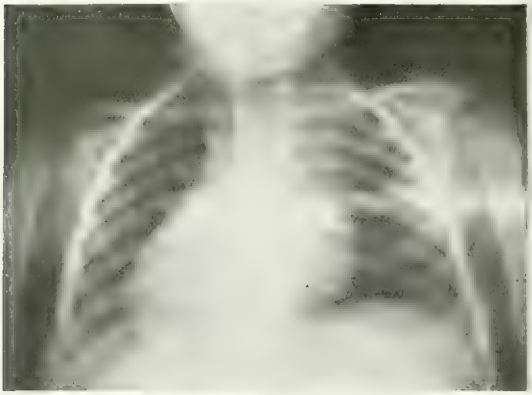
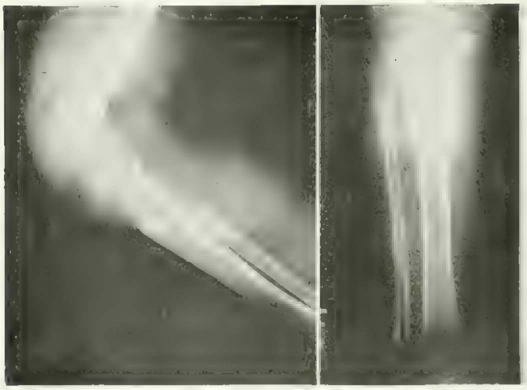
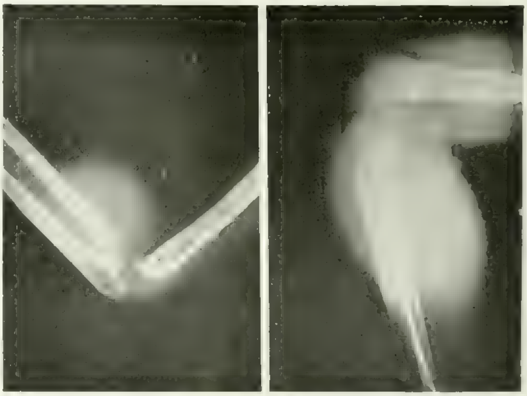


Fig. 6. Case III. Note broad upper mediastinal shadow suggesting thymus gland.



Figs. 9 and 10. Case III. Right leg sixteen days later showing advance in destructive process in tibia and reduction of soft tissue density due to drainage of abscess. Note marked subperiosteal bone production in a. p. view. No involvement epiphysis.

Case III. Male, Mexican, aged three. Entered hospital March 21, 1919. Died May 1, 1919. Resident all life in county. Family lives in shack. Uncle lived with family and died of tuberculosis one year ago. Diarrhea for year previous to entrance. Swollen right knee and ankle and multiple abscesses of arm, forearm, scalp, face and back, some discharging thick, yellowish pus. No pain except on movement right knee and ankle.



Figs. 7 and 8. Case III. Note marked soft density and local enlargement, with no bone lesion in arm but fairly advanced lesion in upper right tibia.

Autopsy. Fibrinous pleurisy; miliary granuloma both lungs and meninges. Multiple abscesses involving subcutaneous structures, muscle and tendon sheaths and bone.

Roentgen Examination. Very definite widening of the mediastinal shadow in the upper chest; suggests persistent thymus. Heart large and infantile in type. Considerable mottled density out from the right hilum and into right apex (Fig. 6). Radiographs of pelvis and femora negative.

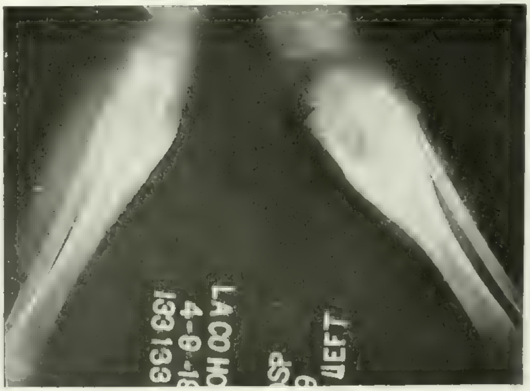
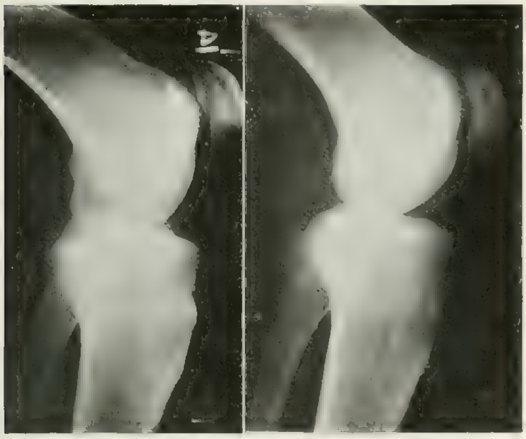
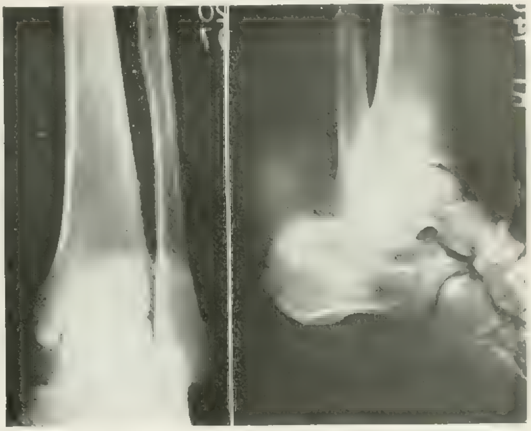


Fig. 11. Case III. Left leg. Destructive process in tibia more marked than in right leg. Note also very marked proliferation. No involvement epiphysis.

Right and left arm and forearm show no definite bony changes, but marked increase in soft tissue density in the lower two-thirds of the right arm and upper forearm, and left upper forearm and elbow regions (Fig. 7). Lateral views of the right knee and leg show marked soft tissue swelling of the leg both anteriorly and posteriorly, and a destructive process in the proximal end of the diaphysis of the tibia (Figs. 8, 9 and 10). The left leg and knee show less soft tissue density, due to the fact that the abscess had been drained, but show a destructive process greater in extent in practically the same portion of the tibia (Fig. 11). There is a marked and definite layer of new bone shown under the periosteum that extends from this area to the middle and lower third of the tibia both anteriorly and posteriorly. Anteroposterior and lateral radiographs of the same area taken a little over two weeks later show an increase in the destructive process in both tibiae, and less soft tissue density due to drainage, and a very marked periosteal proliferation. This is shown in both tibiae at this time. As far as can be made out there is no involvement of the epiphyseal line, epiphyses, or the femora.



Figs. 12 and 13. Case V. Right patella. Note change in period of three weeks.



Figs. 14 and 15. Case V. Soft tissue density markedly increased about ankle, but no demonstrable bone lesion. Autopsy two weeks later showed marked destruction of astragalus.

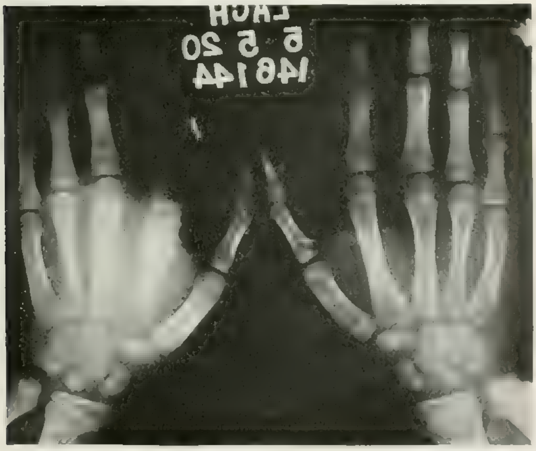


Fig. 16. Case VI. Marked soft tissue density and proliferation in metacarpal. Left hand for comparison.

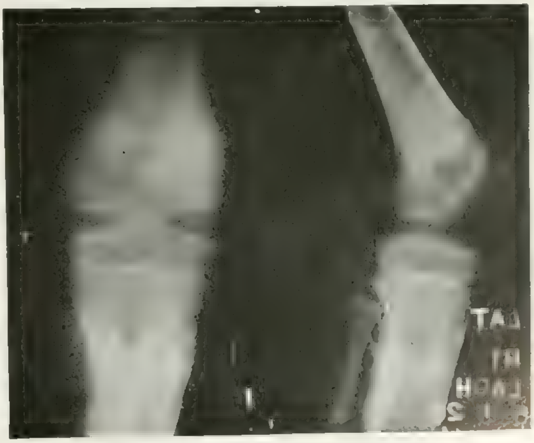


Fig. 17. Case VI. Thickening and proliferation in upper tibia with destructive process in center. No involvement of epiphysis.

Case IV. Male, Mexican, aged seven.

Entered hospital May 22, 1919. Discharged, not improved, June 4, 1919. No history obtained.

Scaly swelling bridge of nose. Discharging sinus under both right and left sides of mandible, right elbow, and fifth finger, left thumb, ankle and fourth toe. Enlarged inguinal glands and left popliteal tumor mass. Had what was said to be a pathological fracture of bones of right leg while in hospital.

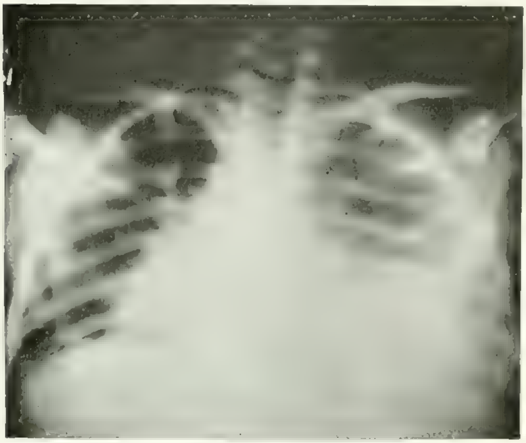
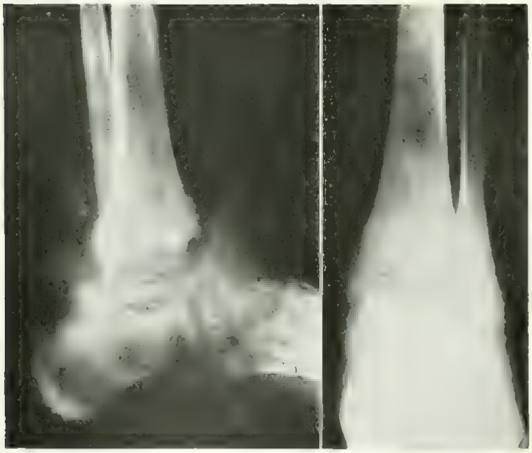


Fig. 18. Case VI. Probable fluid right base.

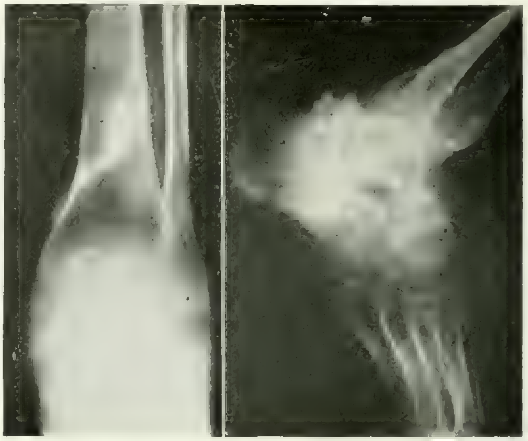


Figs. 21 and 22. Case VIII. Marked involvement both ankle-joint and tarsals. Leg amputated and patient well and working.

Removed from hospital when guardian was told case was hopeless. Subsequent history unknown, but undoubtedly died.

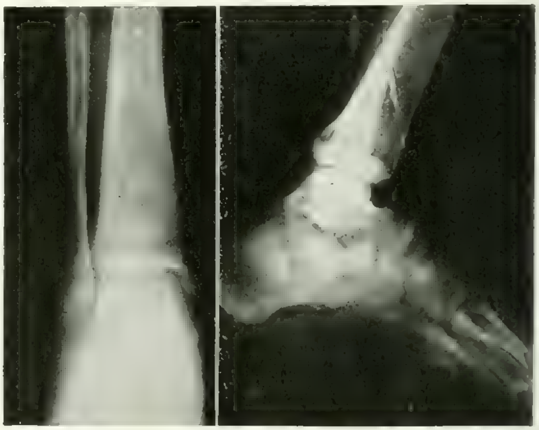
No roentgen evidence available.

Case V. Male, Mexican, aged thirty-four, laborer. Entered hospital Nov. 18, 1919. Died Feb. 11, 1920. Resident in California two years.



Figs. 19 and 20. Case VII. Apparently no involvement of ankle-joint. Marked involvement of astragalus and os calcis with both proliferation and destruction.

Swelling left knee one month; right knee and both ankles and right hip two weeks. Joints painful and stiff. Soft reddish nodule right eyebrow one week.



Figs. 23 and 24. Case X. Destructive process internal malleolus and juxta astragalus and fifth metatarsal. Amputated. Discharging sinus in stump for a year. Recently discharged well.

Autopsy. Multiple subcutaneous abscesses. Abscesses left psoas and lumbar muscles. Encapsulated nodules, peribronchial lymph-nodes. Osteomyelitis sacrum, sternum, patella and right astragalus.

Roentgen Examination. Jan. 6, 1920. Both hips, iliae, shoulder girdles, humeri and elbows negative. Right patella, destructive process lower border (Figs. 12 and 13); left, no bone changes, but soft tissue density increased. Soft tissue density increased in left forearm near wrist, and right ankle. Examination Jan. 28, 1920 shows definite advance in destructive area in right patella; no definite bone lesion in left patella, or in forearm or ankle (Figs. 14 and 15) but marked increase in soft tissue density. No examination of spine made.

Case VI. Male, Mexican, aged nine. Entered hospital Apr. 26, 1920. Died May 26, 1920. Resident in California five years. No history.

Admitted with tumor mass, firm, nodular, movable, in right supraclavicular fossa; large cervical and left inguinal glands. Ulceration over left hip and right posterior tibial region. Fluctuating mass dorsum right hand, index finger missing. General edema left leg and ankle.

Autopsy. Nodules cervical region positive for coccidioidal granuloma. Necrosis left ilium and right tibia. Nodules lower lobe left lung. Acute bronchopneumonia.

Roentgen Examination. Absence phalanx first finger right hand (no history); marked periosteal thickening in the second and third metacarpals, marked soft tissue density (Fig. 16). Right tibia, upper third, shows enlargement and thickening of shaft due to periosteal proliferation and thickening; 2 in. below knee-joint, area of decreased density suggesting bone destruction. Soft tissues markedly thickened (Fig. 17). Right chest dense, especially at base; suggests fluid (Fig. 18).

Case VII. Male, Mexican, laborer. No history available at present time.

Roentgen Examination. A destructive process involving the anterior superior portion of the astragalus, the anterior portion of the os calsis, and a marked irregular proliferative process with increased density in the posterior portion of the astragalus. Ankle-joint not definitely involved (Figs. 19 and 20).

Case VIII. Male, Russian, aged thirty-seven, laborer. Entered hospital May 5, 1920. Discharged, apparently well, Aug. 28, 1920. Resident in state seven years. Had been in Kern County Hospital one month; treated for tuberculosis of bones of foot and ankle. In January, 1920, had influenza pneumonia. In February right ankle got painful and began to swell. In March, it was incised and has drained continuously since.

Admitted with discharging sinus right foot, and right inguinal adenitis.

Roentgen Examination. Destructive process, apparently very active, involving ankle-joint, and most marked in superior portion of astragalus and anterior border of tibia. Bone atrophy marked, especially in tarsals, but apparently no other bones definitely involved, except possibly lower end of fibula. Marked increased soft tissue density and joint haziness. Periosteal infiltration and proliferation in both tibia and fibula for 2 in. above joint (Figs. 21 and 22).

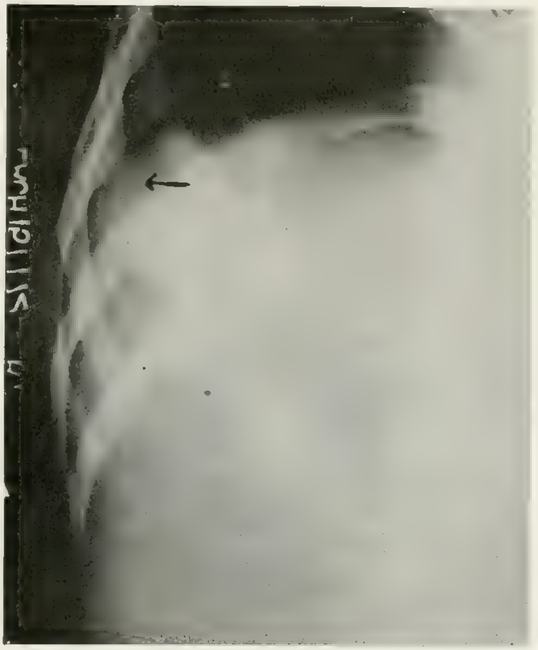


Fig. 25. Case XI. Necrosis seventh rib following subcutaneous abscess.

July 17, 1920. Leg amputated middle and lower one-third. Foot split sagitally and pus between tarsals positive for coccidioidal granuloma.

Jan. 1, 1922. Wears artificial leg and is apparently well. Works every day.

Case IX. Male, Mexican, aged twenty-five, laborer. Entered hospital Jan. 1, 1921. Died Feb. 7, 1921. Resident in state and county ten years. Eight months ago had "fever." For five months has had pain in back and difficult breathing. Entered hospital with discharging sinus 1 in. below right nipple, also 2 in. to the right of the first sacral segment, also right elbow. Two fluctuating masses over lumbar spine.

Autopsy. Numerous and extensive subcutaneous abscesses. Osteomyelitis lower dorsal vertebra, ribs, sacrum, and left ulna. Fibropurulent pleuritis.

Roentgen Examination. Spine negative except sacrum, which showed a destructive process present, as does also the left olecranon. Opacity of left chest, probably thickened pleura and fluid. Probably active tuberculosis right apex.

Case X. Male, Mexican, aged twenty-three, laborer. Entered hospital Feb. 17, 1921. Jan. 1, 1922 still under treatment for sinus in stump, but no evidence of further extension of disease. Resident in Los Angeles County one year. Admitted with gonorrhea and monarticular (left ankle) arthritis, probably gonorrheal. Urethral discharge positive for gonorrhea. Wassermann negative. March 2, 1921, evidence of pus in left ankle. Incised and drained. Apr. 1, 1921, smear of pus from ankle positive for coccidioidal granuloma. Apr. 22, 1921, left leg amputated at middle third. Draining sinus in stump.

Roentgen Examination. Destructive process proximal end fifth metatarsal, internal malleolus, and internal superior border of astragalus (Figs. 23 and 24).

Case XI. Male, Negro, aged twenty, cook. Entered hospital Apr. 1, 1921. Died May 1, 1921. Resident in state and county one year. Admitted with moderately advanced pulmonary tuberculosis. Shortly after entry developed abscesses over right seventh rib anterior, and left sternoclavicular joint.

Autopsy. Miliary involvement both lungs (coccidioidal granuloma), also spleen, liver, kidneys and retroperitoneal lymph-nodes. Left obliterative fibrinous pleuritis. Osteomyelitis seventh, eighth and ninth ribs on right and fourth on left at costochondral junction; also left clavicle at sternal end, and sacrum.

Roentgen Examination. Chest films unsatisfactory. Lumbar spine negative. Destructive process in lower left sacrum and right seventh rib (Fig. 25).

BIBLIOGRAPHY

1. Wernicke. *Centralbl. f. Bakteriol.*, 1892.
2. Rixford and Gilchrist. *Johns Hopkins Hosp. Rep.*, 1896.
3. Rixford and Thorne. *Occidental M. Times*, 1894.
4. Ophuls and Moffitt. *Phila. M. J.*, June 30, 1900.
5. Montgomery, Ryfkogel and Morrow. *J. Cutan. Dis.*, Jan., 1903.
6. Ophuls, William. *J. Exper. M.*, vol. vi, 1905.
7. MacNeal and Taylor. *J. Med. Research*, July, 1914.
8. Dickson, E. C. Arch. Int. Med., Dec. 15, 1915.
9. Lipsitz, S. T. *J. Missouri M. Assn.*, Nov., 1916.
10. Cummins and Saunders. *J. Med. Research*, Nov., 1916.
11. Seilan, J. *Med. Rec.*, Mch. 1, 1919.
12. Bowman, Wm. B. Am. J. Roentgenol., Nov., 1919.

PRELIMINARY OBSERVATIONS OF CARDIAC MEASUREMENTS IN CHILDREN*

BY R. M. TYSON, M.D.

Chief Clinical Assistant, Jefferson Medical College

AND

F. F. BORZELL, M.D.

Roentgenologist to Frankford Hospital; Chief Clinical Assistant, Jefferson Hospital

PHILADELPHIA, PENNSYLVANIA

THIS paper is intended only to be a perliminary report on the measurement of the cardiac silhouette in children, and the work presented with a view toward arriving at some simple and at the same time accurate method of examination that could be used as a routine in any laboratory.

The child presents problems in cardiac examination, in fact, any form of examination, which do not apply in the adult. He is usually restless, and sometimes hard to manage. This is particularly true when he enters the *x*-ray room.

Because of these difficulties, orthodiagraphy and teleoroentgenography can hardly be used routinely. The little patient often will not stand or sit quiet sufficiently long to secure satisfactory results by the procedures named. Any attempt at forcible restraint in the way of bands, etc., increases the child's agitation, consumes the operator's time and usually exhausts his patience.

This agitation causes increased respiratory movement which is undesirable for careful cardiographic studies.

Our observation has been that normal respiratory movements cause comparatively little change in the maximum transverse diameter of the child's heart.

It was these difficulties, together with the advisability of having a technique which would allow for routine examination even in a busy laboratory, that led us to adopt a simple, yet for practical purposes, an accurate, procedure.

I found by making a 6-ft. teleoroentgenogram of a child amenable to instruction, and another teleoroentgenogram of the same patient at a 3-ft. distance, that the ratio of the maximum transverse diameter at 6 ft. was to that of 3 ft. as .9124 is to 1.

This ratio appears to be borne out by other practical mathematical calculations. In other words, if a given image made at a 3-ft. distance measured 10 cm., the image at a 6-ft. distance would measure 9.124 cm.

In a series of 25 children examined, each of whom incidentally had a known valvular lesion, 50 per cent of the measurements coincided exactly with the measurements made by percussion at the hands of a careful clinician. The other 50 per cent showed our measurement to vary from 2 to 15 mm.

Age	Sex	Clinical Measurement	*X*-Ray Measurement	Discrepancy, Mm.
8	F	10.5	10.5	0.0
8	M	10.0	10.9	0.9
9	M	12.0	12.0	0.0
9	F	9.5	9.5	0.0
12	F	11.0	11.0	0.0
5	M	8.5	9.1	0.6
8½	M	9.0	9.0	0.0
10	M	12.0	12.0	0.0
12	M	10.5	10.5	0.0
10	F	11.0	11.0	0.0
6	M	11.5	13.0	1.5
13	M	12.0	12.7	0.7
8	F	12.0	12.6	0.6
14	F	12.5	12.5	0.0
11	F	11.0	11.0	0.0
8	M	11.0	11.8	0.8
9	F	9.5	9.7	0.2
9	F	9.5	10.5	1.0
11	F	11.0	11.0	0.0
11	M	12.0	11.0	1.0
4½	F	9.0	9.0	0.0
11	F	9.0	10.5	1.5
5	F	9.0	9.6	0.6
12	M	11.5	12.0	0.5
. . .	F	11.0	10.5	0.5

The discrepancy of 15 mm. occurred in 2 cases in which the clinician was in doubt as to the accuracy of his measurements, owing to the restlessness of the children. The discrepancy in the other instances may be due to several factors: One, the known inaccuracy of clinical methods; another, the fact that the clinician makes his measurements with the child sitting erect, and his measurements are centered in the mid-sternal line. Another discrepancy noted was that greater value was given to the measurements of the left ventricular border and proportionately less to the right auricular border than my measurements indicated. However, the sum of the two measurements constituting the maximum transverse diameter, according to Groedel, agreed. It was noted also that while the clinician took his right auricular measurement in the fourth interspace, and the left ventricular in the fifth interspace, occasionally the roentgen examination demonstrated the extreme left border as high as the lower edge of the fourth interspace, or as low as the fifth rib, while the right auricular extreme was fairly constantly in the fourth interspace.

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

This range noted on the left side may be attributed to the fact that the exposures were made at different periods in the respiratory cycle.

So that, given a normal respiratory movement, not influenced by pulmonary pathology or undue excitation, the cardiac movement causes insignificant changes in the actual maximum transverse measurements of the cardiac silhouette. The main change is rather in the degree of the angle formed by the line joining the extreme right and left borders.

CONCLUSION

First: This procedure offers a simple, accurate method of securing the cardiac silhouette in children. Second: With this as with other methods of precision, the details must be technically accurate.

Discussion

Dr. Pancoast. During the investigations carried out recently, as a member of the committee appointed by the National Tuberculosis Association to establish the normal *x*-ray appearance of the chest of the child, I took advantage of the opportunity to make some measurements of the heart shadow, in case they might become useful for future reference. The children examined were between the ages of six and ten years. There has seemed to be a prevailing opinion that the right border of the heart extends relatively further to the right in the child than in the adult. This idea was held by me even during the examinations of the normal children, but after the measurements had been made and tabulated later, this did not seem to be borne out, at least not to the extent that was anticipated. The ratio of the median right to the median left measurement was found to be approximately 1 to 2.

The percentage of the shadow to the right side by orthodiagraphic measurements was as follows: Six years old, 29; seven years old, 33; eight years old, 30; nine years old, 34; ten years old, 35; with an average of about 33 per cent. At that time we were making plates of all chests at a target-plate distance of 30 in. In these children, the comparison between the heart shadow on the film at 30 in. distance and the absolute shadow as measured orthodiagraphically showed comparatively little increase in width on the film. The average of the measurements of all children of six years of age showed an increase of 17.5 per cent in the film over the average orthodiagraphic measurements. At seven years, the increase was 17 per cent; at eight years, 13.5 per cent; at nine years, 15 per cent; at ten years, 10.5 per cent. It will be noted, therefore, as Dr. Borzell has pointed out, that there is comparatively little difference between the size of the heart shadow as measured on the film or plate, even when made at so short a distance as 30 in. and the actual size as measured orthodiagraphically.

We have recently increased our target-plate distance for chest examinations to 4 ft. By using Agfa films in place of Eastman films it has been necessary to increase the time of exposure about 25 per cent only.

I think we all realize the shortcomings of our present methods of heart investigations, and that we do not obtain all the information we should. Unless we choose to adopt very complicated methods, our present technique is exceedingly crude and of little practical value. Too little attention is usually paid to the variations in measurements between stout and thin individuals. Our conception of the right ventricle is practically nil. Surely the clinician and the roentgenologist should get together and devise some plan of action that would be worth while.

Dr. Groedel. I have to thank you for the kind invitation to address this meeting and for the opportunity to discuss this very interesting paper. There is, of course, a difference between the technique of exposure for the heart of an adult and that of a child. The distance between the chest wall and the heart is less in an adult than in a child; therefore, I think it is quite the same if you take a two or a six-foot plate in children.

I am astonished to hear that you have difficulties in making short *x*-ray exposures. We had no difficulties formerly when we had good *x*-ray tubes, good intensifying screens, etc. Now, of course, all our material is so bad that we too have difficulties in this direction and we seek a method of overcoming them. For this reason we are trying now to make an orthodiagram in every case, if possible. I have always been of the opinion that it would be better to make an orthodiagram than to take plates, because by this method we not only get the real size of the heart, but also of the lungs. I find the best measuring method is to compare the transverse diameter of the heart with that of the base of the lungs. One can judge by the two diameters whether or not the heart is normal. Regardless of whether the patient is stout or thin, in every normal case the diameter of the heart is half the diameter of the lungs, and we find there is no material deviation in this measurement.

One cannot make this comparative measurement by teleoroentgenography, because here the ratio of the size of the heart does not remain the same as that of the lungs. Thus, if the actual transverse diameter of the heart is 10 cm., you will have an error on the plates of perhaps 2 mm.; if the actual transverse diameter of the lungs is 20 cm., you will find an error of perhaps 6 or 7 mm.

In this country, with all the available good material, plates and intensifying screens, it should be possible to take instantaneous six-foot plates—perhaps eight-foot plates—and see if the diameter of the heart is not one-half the diameter of the lungs. It is really an important question. In any case, I cannot say anything against this method.

WATER-CANCER OR GANGRENOUS STOMATITIS TREATED WITH THE X-RAY*

BY J. W. CATHCART, M.D.

EL PASO, TEXAS

History of Case

INDIAN of Old Mexico, male, aged about twenty-five years. A soldier. Accompanying one of the revolutionary bands that have traversed northern Mexico for the past ten years. He crossed over the river at El Paso and on account of the seriousness of his condition was admitted to the County Hospital. He gave history of ulcer starting in his mouth one week previous following which time it had rapidly developed, as shown by Figure 1. He was referred to the X-ray Department and given an erythema dose of unfiltered x-rays, using a 6 in. back-up. This was repeated in three days, producing a second degree burn. Infection rapidly subsided and the burn healed promptly. In six weeks the patient was entirely well and was presented to the El Paso County Medical Society. He was then referred back to the Surgical Department where a plastic operation was attempted, following which there was a slight local recurrence with a septic focus in the central nervous system to which he quickly succumbed. This case is reported merely to show that the x-ray will control gangrenous stomatitis, as it was the only agent used other than nourishing food, the lack of which was probably the causative agent.

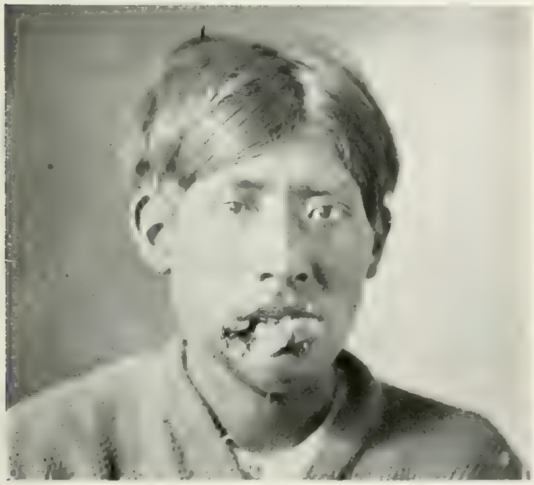


Fig. 1.

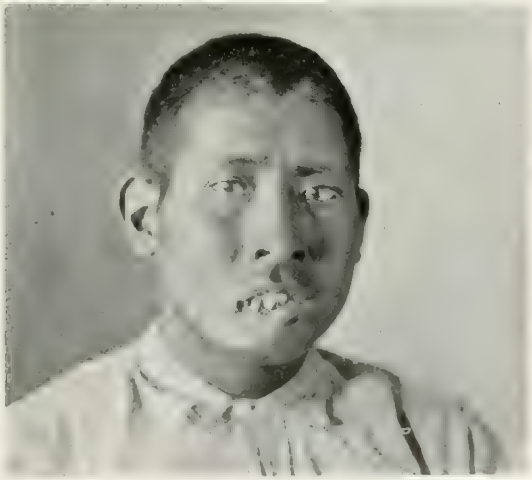


Fig. 2.

---

* Paper submitted with application for membership in The American Roentgen Ray Society, 1921.

A DEVICE TO PREVENT THE OMISSION OF A FILTER IN DEEP ROENTGEN THERAPY*

BY GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

TO any one who is competent to do deep roentgen therapy, no arguments need be presented to indicate the importance of not omitting the filter while giving a dose of roentgen rays.

At a meeting of this society at Washington, D. C., Sept. 27 to Sept. 30, 1921, I presented a simple method for this purpose consisting of colored ribbons which hang from the filter below the tube on the tube stand and serve as indicators either of the absence of a filter or the presence of a certain kind of filter. This has served fairly well, but it is only applicable to the overhead tube stand which the operator can see easily from the observation window as the switch is closed.

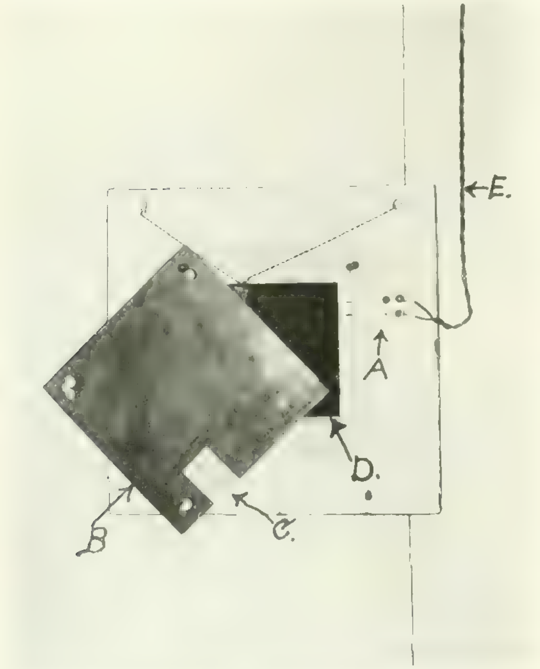


FIG. 1. A indicates the two springs which make contact with any diaphragm that is put in place without the filter, and close the circuit which rings the bell. B shows the copper diaphragm, C, the adhesive plaster on the copper diaphragm which prevents the springs from making contact, D, the open diaphragm, E, the wire to the batteries and the bell.

Since then, I found this ribbon indicator in use in several of the clinics in Europe. No mention was made to me of my being the originator. Therefore it is entirely possible that someone in Germany conceived the same idea, but this is only another argument as to its necessity and its applicability.

This ribbon indicator presupposes that the operator knows the meaning of the ribbon and will take quick cognizance of the absence of the desired filter.

More recently a number of us have found it desirable to operate our deep therapy tubes from underneath the floor or table, or from the opposite side of a leaded wall, or inside a leaded cabinet, so as to eliminate gases, much scattered radiation, and electrical dangers.

With the above arrangements a ribbon indicator is useless. Therefore, with the assistance of my mechanic, Mr. Thomas Gallon, we have developed a device which will excite a loud-ringing door bell when the filter is omitted, thus making it seem utterly impossible to continue the treatment with the absence of the filter. Its installation varies somewhat on each of our three outfits, but in principle they are the same, and any one with a little ingenuity and the understanding of electrical principles, can adapt it to his particular use.

It consists of two pieces of spring wire, each attached to the opposite pole of two dry cells, and in series with a hammerless door bell (Schwarz Electric 3″ Bell). When the filter is in place it has on its surface a non-conductor such as a piece of adhesive tape, which prevents the closing of the circuit. When the filter is removed, the springs come in contact with the diaphragm or frame of the diaphragm holder, the circuit is closed, and a bell rings, that no one can ignore.

In the installation through the side of the wall, Figure 1, we would probably never use the rays through the full open space. One could easily see the light from the tube, or the tube itself. When a diaphragm is put in place it instantly makes contact and the bell rings until it is removed and the filter put in place.

---

*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

In the outfit which makes use of a hole in the floor, which space is covered with a mattress and where one can see nothing under any circumstances, it is so arranged that when the filter is removed the two springs come in contact with two pins connected electrically; or if a heavy lead diaphragm is in place without the filter, the circuit is closed through the lead and the bell rings until the filter is put in place.

In the Rieber outfit, which has the tube enclosed in a table, the arrangement is similar, excepting that instead of using dry cells, which after a year may become exhausted, the desired bell-ringing voltage is secured from two taps of the auto-transformer directly from the machine itself. Then the bell rings when the motor is started, if the filter is not in place.

This same idea can be applied to the ordinary tube stand, and for use with the lower voltage therapy. The batteries can be attached to the base of the tube stand and therefore moved with the tube stand. The springs can be so arranged that they come in contact with either a diaphragm or the metal support for the tube, and thereby close the circuit.

It is clearly our duty to protect our patients and to avoid unnecessary mental anguish. I would therefore urge that each one of you take some step to prevent the omission of a filter. Especially do I urge this upon those of you who are doing deep therapy.

DISCUSSION

Dr. Groover. The device described by Dr. Pfahler is so simple that very little needs to be said about it. About all I can say is to emphasize the importance of some foolproof device for preventing accidents due to the leaving out of filters.

We should exercise eternal vigilance; and such mechanical aids as Dr. Pfahler mentions are certainly of great help.

I have used the ribbon method that he described some time ago. Incidentally, instead of ribbon we use a string with a poker chip attached, having different colored chips for different thicknesses of filter.

I think his new method is an additional safeguard, but it should not lead us into the habit of substituting our sense of hearing for our sense of sight.

A NEW TUBE HOLDER FOR ROENTGEN THERAPY*

BY THOS. A. GROOVER, M.D., A.C. CHRISTIE, M.D., AND E. A. MERRITT, M.D.

WASHINGTON, D. C.

ADVANTAGES which seem to be inherent in certain tube holders designed for use with apparatus delivering upwards of 200,000 volts, in which the entire tube is enclosed in a lead case, have led one of us (Merritt) to design and build a tube holder embodying the same principles for use with lower voltages, having certain modifications which give it a range of flexibility comparable to the tube stands commonly used for this purpose.

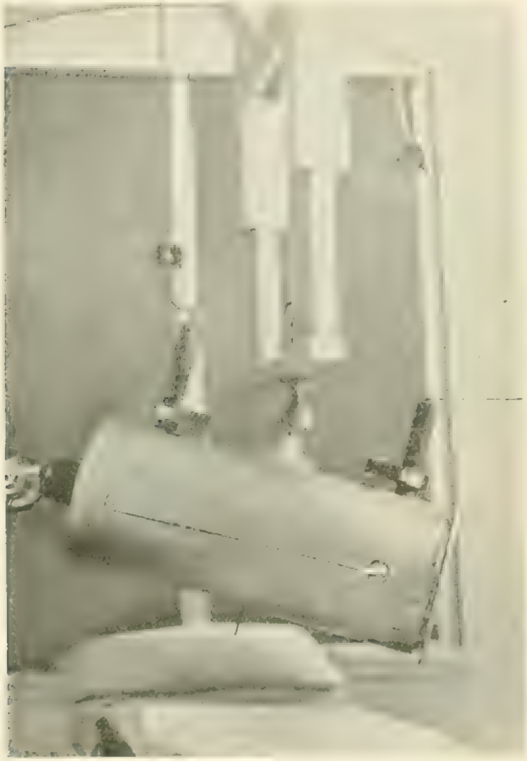


FIG. 1.

The apparatus consists essentially of a wooden cylinder 31½ in. in length with an inside diameter of 12 in. This cylinder is covered with sheet lead weighing 5 lbs. to the sq. ft. The end corresponding to the anode of the tube has a hinged door covered with lead, so designed that when closed, an aperture of ½ in. remains between it and the periphery of the cylinder, for the purpose of ventilation. The opposite end is permanently closed and lead-covered except for an aperture 2 in. in diameter for the accommodation of a connection for a fan which drives a constant stream of air through the cylinder, when the tube is in operation.

The high tension current is brought to the tube terminals by brass rods passing through paper insulators 2 in. in diameter which are provided with appropriate tube connections which also serve to support the tube in its proper position.

The insulators are held in position by felt-lined wooden clamps which permit their easy removal when necessary.

Midway between the insulators is a bronze casting having a universal joint, one member of the casting being attached to the cylinder and the other to the crossbeam of the raising and lowering device. The ball of the universal joint is 1¾ in. in diameter and permits an excursion of 45 degrees in any direction. It is provided with a locking device to hold the cylinder in the position desired. Handles are attached to the sides of the cylinder to facilitate its manipulation.

The raising and lowering device consists essentially of two wooden tunnels securely fastened and braced to the ceiling. These tunnels receive the upright members attached to the crossbeam previously mentioned. A flexible wire cable extends from the crossbeam to a pulley and counterweight and is grounded to a water-main. The counterweight weighs 80 lbs.

The device permits an up and down movement of the cylinder for a distance of 24 in.

The table for use with this apparatus must be of appropriate height and provided with roller-bearing casters. A step attached to one side of the table is a great convenience.

The apparatus described, contrary to appearances, is of easy manipulation and we believe has the following advantages:

1. It affords complete protection to the

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J. Jan. 25-27, 1923.

operator from radiation and eliminates the necessity of constructing expensive booths.

2. The patient is also protected from all radiation except such as is directed through the aperture intended for that purpose.

3. We believe that the device[1] safeguards the patient from electrical shock.

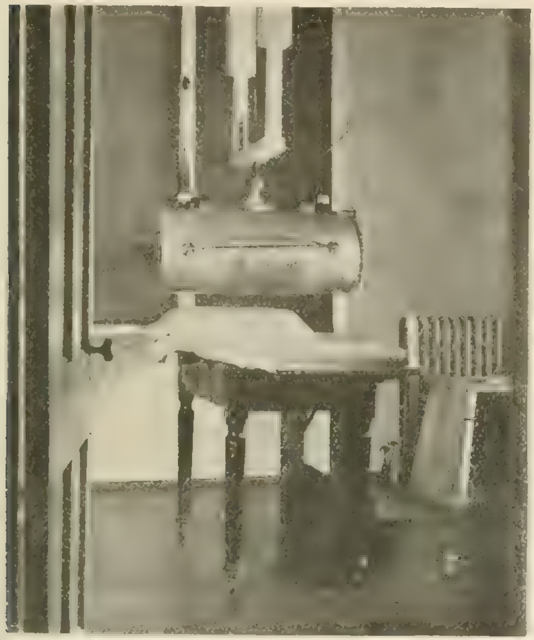


Fig. 2.

4. The risk of tube breakage and puncture is lessened.

5. The apparatus is not expensive. It can be reproduced for about $125.00 if the brass casting is made from the original mold.

DISCUSSION

Dr. Darling. Apropos of this tube stand for deep therapy work, I think I have some suggestions that would save a great deal of money.

In the first place, it seems to me that the overhead principle as emphasized by Dr. Groover is correct, and to my mind a flexible arrangement where you can point the ray up or down the table, raise or lower, is a good principle. Suspension of the weight without danger of a fall of the whole apparatus on the patient is, of course, desirable. Now all this has been very well done in a type of tube stand which is on exhibit here and manufactured by the Wappler Elec. Co. I have used that tube stand and it does away with all of this basement proposition with concrete floors for protection; it does away with lead walls and all expensive construction, and gives protection to the operator. It meets every problem, as far as I can see, that arises in the treatment of these cases. This has already been carefully worked out and you can move it from office to office. It looks to me like a permanent addition to our equipment.

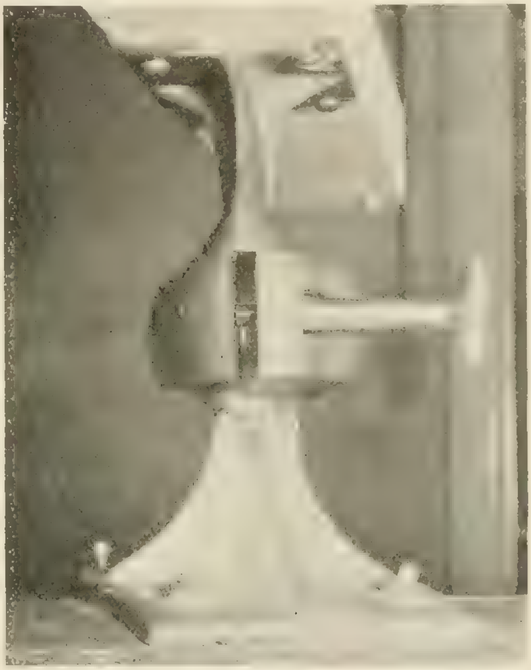


Fig. 3.

Dr. Grier. I would like to say that we have had an apparatus like this in our laboratory for seven or eight years. Some of the members have seen it. Ours differs from this only in that the box is square instead of round and a slot is cut in it which obviates the necessity of moving it—simply reach inside and move the tube. The area through which you do not wish to treat is covered by pieces of lead.

Dr. Johnston described it before the midwinter meeting of this society some seven or eight years ago and it has been published in our Journal.

Dr. Groover (closing discussion). We

---

[1] Since reading the above paper, we have improved the apparatus by providing a safety device which effectively prevents the cylinder from dropping in the event that the suspending cable or counterweight should fail to function. This consists essentially of a ratchet device (not shown in the illustrations) attached to the wooden tunnels which automatically prevents the cylinder from descending, except when the safety catch is held released by hand.

wish to emphasize that the apparatus we have shown is designed for the accommodation of the standard Coolidge tube. We are using it backing up a spark-gap of 9 or $9\frac{1}{2}$ in.

I appreciate very well the criticism Dr. Bowen has made and I think his point is well taken. Of course, a similar objection can be made to every piece of apparatus that is controlled by a counterweight. I do not know of any foolproof way of obviating that particular difficulty.

I have overlooked the fact that Dr. Johnston had constructed a piece of apparatus embodying very much the same principles.

I think it is an advantage in doing therapy to have the entire tube enclosed regardless of the voltages used. It is quite true that the device Dr. Darling mentions embodies exactly the same features as this, but there is an important difference: that that apparatus costs something over $1,200 and this can be built for $125.

DEEP ROENTGENOTHERAPY IN THE TREATMENT OF CARCINOMA OF THE BREAST*

BY GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

THE term "Deep Roentgenotherapy" has come to be applied to the use of roentgen rays produced by voltages of over 100,000, and generally in the neighborhood of 200,000. Therefore it is often referred to as "High Voltage Treatment." Such high voltages produce rays of shorter wave-length. Generally the effective wave-length is in the neighborhood of from 0.15 to 0.18 of an Angstrom unit. Formerly we worked with an effective wave-length of about 0.22 to 0.23 of an Ångstrom unit. As a matter of fact, we have been doing "deep therapy" for about twenty years, or ever since we have successfully treated deep-seated disease, and especially deep-seated malignant disease.

We have, however, made great improvement, because the newer rays are more penetrating and the newer apparatus and the new technique enable us to deliver to the deeper tissues a greater percentage of the surface dose. Therefore, without producing a dermatitis we are able by skillful technique to produce a destructive effect upon cancer in the deeper tissues without destroying the overlying skin. It must be borne in mind that this is only a relative condition, and that in any given dose the greatest absorption and the greatest effect are in the surface tissues. The deeper values are obtained chiefly by cross-firing, but in such cross-firing, skill is necessary not only to deliver the desired quantity to a given point, but to avoid delivering too much radiation at any point where the rays are crossing, and thereby producing a deep-seated necrosis, perhaps in normal tissue.

These high voltage machines require also the greatest caution with regard to the electric dangers. One must not be misled by the technique seen in some of the leading clinics of Europe, where one can see used a focal skin distance of 23 cm. In such instances a coil is being used, and not one of our high voltage transformers. The coil will give a serious shock, but probably nothing more. On the other hand, if a spark leaps from a transformer to the patient, it will likely produce death, because of the large volume of current which it will draw.

Probably the best means of protection from the electric dangers is to have a lead wall between the patient and all wires, including the tube. The next best arrangement is probably a complete insulating cover over the patient, such as the opaque rubber, which not only protects from accidental current, but from stray rays.

Your President has asked me to present a paper upon this subject of carcinoma of the breast and to call your attention to some of the dangers in this deep therapy work, not taking for granted that these things are well known and always remembered. Deep roentgenotherapy is no child's play, but requires a thorough medical knowledge of diagnosis, pathology and clinical medicine; a knowledge of electricity and physics; skill in radiology, and a deep sense of responsibility; for one can be so cautious as to accomplish nothing, in which instance one may be throwing a life away, or at least throwing chances away. On the other hand, one can be so bold or reckless as to cause serious damage, and perhaps death.

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25-27 1923.

In the treatment of carcinoma of the breast we have a more difficult problem than in the treatment of carcinoma of the uterus, because there is less chance of cross-firing. In dealing with the uterus we have the diseased tissue located practically in the center of an oval body, and by careful measurements and skill one can deliver sufficient radiation into the diseased organ to destroy the cancer cells. In the pelvis, one can either obtain a homogeneous radiation as recommended by Dessauer from the four surfaces, or one can use several fields anteriorly and posteriorly, so as to cross specifically on the diseased tissue locally, as recommended by Wintz.

In carcinoma of the breast, the disease is not centrally located, excepting the metastasis which may have reached the mediastinum. The local tumor is situated under the skin, but at one side of an oval. Therefore one must deliver the greatest possible relative depth dose through the mammary region. Then one must supplement this by the radiation from the axillary portal of entry and from the posterior surface of the chest, sufficient to make a total of about 120 per cent of an erythema dose.

In each instance, the rays must be directed toward the deeper portions of the breast tumor. In many instances it will be impossible to deliver sufficient radiation throughout the tumor. Then one must supplement the roentgen radiation by the insertion of radium needles or emanation tubes. These indications will also apply to the tumor masses in the axilla and the supraclavicular regions. The axillary and supraclavicular metastases are usually nearer the surface than the tumors in the breast, but unfortunately, there is even less chance for cross-firing. Therefore all three of these areas need great relative depth values.

It is my custom at present to use rays having an effective wave-length (Duane) of about 0.17 Å, produced by about 200 to 210 kv., 62 cm. distance, 4 ma., with a filter of 0.5 mm. Cu + 2 mm. glass + 25 mm. mattress. With these factors on one machine I obtain an erythema dose in sixty minutes (or seventy-five minutes as a maximum toleration dose).

The treatment is given in my private laboratory; and therefore, to avoid too much constitutional effect on the patient, we give one such dose, as a rule, on alternate days. Four portals of entry are used: one through the mammary region, one through the axillary, one through the supraclavicular region, and one through the posterior thoracic region. This can be repeated once at the end of six weeks.

With this deep therapy I have seen better results than have been obtained by the lower voltage treatment. I will refer to three illustrative cases, all of which are records of stout patients in whom it is well known that the disease spreads rapidly and is more difficult to control. Stout patients offer also more difficulties to the radiologist, because of the deeper distribution of the disease. All three of these patients had advanced disease which could not be expected to disappear with the lower voltage treatment.

Case I. Female, aged forty-nine, was referred on July 29, 1922, by Dr. E. H. Bainbridge and Dr. E. S. Sheldon, for treatment by high voltage *x*-rays.

One year previously, the patient had noticed a tension in the right breast, and felt a lump the size of a walnut. The breast continued to get larger until the entire breast was indurated and tender. She had palpable metastases in both the right axilla and the supraclavicular region. Dr. Bainbridge, by *x*-ray examination, found metastases in the lungs.

Our *x*-ray examination showed thickening of the mediastinal tissues and pulmonary infiltration at the base of the right lung, which we believed were metastatic carcinoma.

She was given a dose of rays over the right mammary, the right axilla, the right supraclavicular region, the right chest posteriorly, and the left axilla in which the rays were directed toward the mediastinum, within a period of two weeks. Such a course of treatment has been repeated three times to date. Each dose consisted of 200 kv., 4 ma., 60 min., with a filter of 0.5 Cu. 2 mm. glass × .25 mm. mattress at a distance of 62 cm.

On Nov. 1, 1922, we introduced 20 radium needles of 10 mg. each into the tumor tissue and into the nodules in the axilla.

The general breast is now soft. The tumor area is contracted to about 25 per cent, is freely movable, and is probably fibrous tissue. It is almost impossible at this stage to decide whether the remaining tumor tissue is only fibrous, or whether there are remaining some carcinoma cells; and for this reason, if there is no reasonable objection, the breast had better be removed. In one such case we found a few cancer cells remaining. In another we could find no cancer cells remaining, and all the diseased area was changed to fibrous tissue.

The dense tissue in the lower portion of the right lung which was present before beginning treatment has now become distinctly fibrous, and the general lung area is contracted. Whether this was originally cancer tissue which now has become fibrous, or whether it was originally a fibrous process which was further increased by the radiation, has not yet been determined.

As a whole, we believe the results are better than those we have obtained with lower voltage treatment.

Case II. Female, aged thirty-nine, referred Sept. 15, 1922, by Dr. R. H. Milwee of Dallas, Tex. About a year previously the right breast was bruised accidentally. It became "black and blue" following the injury. About a month later a tumor developed, which grew progressively larger until the entire breast was tumorous, with tumor masses in the axilla about 4 cm. in diameter. There were small palpable lymph-nodes in the supraclavicular region, and abnormal infiltration in the upper mediastinum.

Since then, the right mammary, axillary region, supraclavicular and posterior right chest have each been exposed three times, and the left axilla once, to the following dose of high voltage *x*-rays: 200 kv. × 4 ma. × 60 min. at a distance of 62 cm. through a filter of 0.5 mm. Cu. × 2 mm. glass × 25 mm. of mattress, with the result that no palpable malignant disease is found.

This is a better result than I have seen in such an advanced case before.

Case III. Female, aged forty-seven, was referred to me Jan. 13, 1920, by Dr. Harry Deaver. In May, 1919, the patient had a small nodule removed from each breast. These were found to be malignant. Therefore a radical operation was done on the left breast in June, 1919. Because of severe shock following this operation the right breast was not removed until Dec., 1919.

When she was referred for *x*-ray treatment she had palpable supraclavicular glands, and disease in the upper mediastinum radiating outward from the roots of the lungs, which we believed was metastatic carcinoma.

Within six months she was given five courses of low voltage *x*-ray treatment, and all palpable disease had disappeared. On June 11, 1921, an *x*-ray examination of her chest showed no evidence of disease.

On Oct. 17, 1921, Dr. Deaver sent the patient back for treatment because of a nodule at the junction of the upper ⅔ and the lower ⅓ of the scar, and swelling of her left arm, and increased firmness in the left subcoracoid region. The mediastinum remained clear. Treatment with 90 kv., 5 ma., 40 min. at a distance of 40 cm. through 6 mm. Al. filter through the mammary, axillary, and supraclavicular region, and a double dose over the nodule caused a complete disappearance of the evidence of recurrence. She remained well until Apr., 1922, when she began to have pains in her back. *X*-ray examination of the spine and pelvis showed undoubted metastatic disease of the 1st and 4th lumbar vertebrae, and also of the iliac bones on each side. On account of general discouragement no treatment was given until June, 1922, when the disease was found increased. A brace was made to support her spine. The entire spine and pelvis has been treated four times since then: 200 kv., 4 ma., 60 min. at a distance of 62 cm. with a filter of 0.5 Cu. × 2 mm. glass × 25 mattress over each area. The disease areas have recalcified, and her general health is good, and she has increased in weight. It would seem utterly impossible to have accomplished such results in such a stout woman with the older type of radiation.

I am thoroughly convinced that we have in our hands increased power which we must learn to use skillfully.

DISCUSSION

Dr. Stern. I was very much interested in Dr. Pfahler's paper on the high-voltage treatment of carcinoma of the breast.

I think that at this minute we are still up in the air as far as the proper technique is concerned. I have spent the last fourteen months in trying to come to some conclusion as to what is the best technique, and I still do not know.

When I returned from abroad, after visiting a number of clinics and listening to some of the wonderful results reported, I thought I would try in succession, the various techniques suggested, and decide for myself as to the best one to follow. The first I tried was the one I saw in Freiburg. They use 200,000 volt current 1 mm. Cu. and 2 mm. Al. filter at a distance of 50 cm. Their erythema dose is four hours. Fields of exposure, one large field from the front and one from the back. I tried this on an old lady of eighty who had one of the most malignant carcinomas I had ever seen. Most of these cancers in old women are of the scirrhous type that do not show much malignancy. This was an unusual case for that reason. Within about two weeks after the cancer was discovered it practically doubled in size; it metastasized a little further up and went under the arm. She was treated in Washington for some time with what I considered very efficient low voltage treatment. In spite of this, it began to grow rapidly until it reached a considerable size. When I first saw her she had a little bronchitis and the question came up as to whether we should wait with the treatment until the bronchitis disappeared. As some of these cases of old chronic bronchitis take a long time to disappear, and her condition seemed very serious, I decided that she had better be treated as soon as possible. The immediate result I thought was very satisfactory; the tumor practically disappeared. Shortly after the treatment I found that there was a very decided congestion on the side that was treated. This spread until very large parts of both lungs were involved. We do not know whether we were dealing with a metastasis or whether the treatment set up an intensive pneumonia which finally carried her off. You must realize that when you get 110 per cent to 120 per cent into the growth you will probably get near 100 per cent on the pleura, a dose which may set up a decided inflammatory condition.

The next technique I tried was with the use of ¾ mm. zinc and 2 mm. Al. filter at a distance of 50 cm. with 3 ma. Under these conditions my erythema dose is two hours. Here I also used two large ports of entry front and back. This patient also did well, but the treatment was again followed by a marked congestion of the lungs on the side treated. This remained fairly well localized. Keeping the pleura in mind, we decided that we were probably dealing with a pleurisy with effusion; puncturing confirmed this and after withdrawing the fluid the patient did very well. Of course it is very difficult for us to decide whether the pleurisy with effusion was due directly to the treatment or whether it was merely co-incidental. I personally feel that the treatment was largely responsible for it. In other cases I used the technique Dr. Pfahler warned you against—getting 23 cm. near the tumor. I think you can get as near as this and still keep every part of your tube at a safe distance from the patient. It is only a question of proper protection to the patient and careful adjustment of the tube holder. In working at this short distance you can take in only rather small fields. Hence the treatment is best adapted for older patients with localized growths and without glandular involvements. Many of these patients did very well indeed. There was a complete disappearance of the tumor without complications. This technique has the additional advantage of requiring considerably less time, thereby minimizing the amount of constitutional disturbances which in older patients may be rather serious. There is no doubt that with the higher voltage technique we have something at our command which enables us to get our required percentage of depth dose, which with our low voltage treatment in many cases was practically impossible. As to the best technique to adopt in the treatment of these cases, it is still rather undecided. At least I have personally not come to any definite conclusion. Probably the best thing to do is to decide each case upon its individual merit and choose the technique that will best answer our purpose in that particular case.

Dr. Sittenfield. This paper on carcinoma of the breast has interested me greatly, inasmuch as I had the opportunity of presenting to the Clinical Society of the District of Columbia at Washington, two months ago, a report of 114 cases of carcinoma of the breast treated with the high voltage technique within the past two years and four months.

What Drs. Pfahler and Stern have said about technique is perfectly true, though there is no one fast and set rule that can be applied to every case of cancer of the breast. In thin persons, for instance, where the tumor is situated 3 or 4 cm. under the surface of the skin, one large field, 24 cm. square at a high focal distance (and by high focal distance I mean 80 to 100 cm.) will be efficient. In another case it may be necessary to use four fields—anterior, posterior, axillary, and supra-clavicular—at 40 to 50 cm. focal distance.

I have felt of late, however, and have discussed it with my colleagues, that I am not quite satisfied that one intensive dose does the trick. I have felt that it was necessary to administer as much as the skin can tolerate, from 100 to 150 per cent of a Skin Erythema Dose at one session. By one session I do not mean one eight- or ten-hour treatment in one day. I mean radiation for about two hours daily over a period of from four to eight days. Daily examination of the blood will show that there has been considerable damage done to the cells and it is therefore not wise to repeat the second dose within six weeks. After that the dose can be repeated, and a third dose after a lapse of three months, if necessary. I have done this within the last nine months and I am much better satisfied with the outcome.

Perhaps it would be interesting to point out that we are dealing constantly with different types of carcinoma in the breast according to their clinical and biological evidence. It is not fair to state that we have treated 114 cases of carcinoma of the breast as one class unless something is said about the group and classification of these cases. In one group the tumor may be localized in the breast and remain local in the breast for some time, and it may be years before it metastasizes and becomes very malignant. This type will respond favorably to radiation or surgery. In the other type we have tumors of the breast which metastasize very rapidly either into the axillary, supraclavicular or as Handley states, into the pectoral fascia.

We are dealing here with two different types of cancer. This is important to bear in mind because we do not get the same results in one type as in the other. First of all, the clinical and biological malignancy of the lesion has everything to do with the result obtained. In the cases described as Group 2, where the lesion has already spread to axillary and supraclavicular regions, I am afraid that radiation or surgery is not going to benefit this type of patient to a very great extent. In order to meet this classification and to administer treatment accordingly, one must adopt means and methods best suited to administer 300 to 400 per cent of a S.E.D. to the lesion itself. At times it is essential to use a paraffine block 3, 5, or 7 cm. over the surface of the skin in order to treat that lesion as a deep-seated one, and in this way to get as much from the anterior part of the chest as from the posterior field. At other times it is necessary, in order to increase secondary radiation, to use a water bag or an ox-bladder filled with water to obtain a better absorption coefficient.

In other words, we must get away from the former fixed idea that one carcinoma dose will do for every case. It is absolutely necessary to improvise radiation technique in every individual case to fight any one type of carcinoma of the breast.

Dr. Pirie. When this high-voltage treatment came in and we got first information on it, I think the statement was unfortunate that 112 per cent of an erythema dose was the dose with which to kill cancer. Dr. Sittenfield had absolutely contradicted that, and I am glad to hear it. I contradict it myself. I do not say that 112 per cent of an erythema dose will not kill cancer, but there are many which it will not kill. In one case I have given five erythema doses and it did not kill the cancer.

We had yesterday an example of the difference in susceptibility of mice cancers to *x*-rays. Certainly the same is true of human cancer; and we must work out a technique that will kill every one. If a cancer is supposed to be killed by 112 per cent of an erythema dose, I do not see why it should not be killed with five erythema doses as well. The patient will stand five erythema doses just as well, and it is perfectly safe to overdose a patient.

The systemic effects are a great drawback. Dr. Pfahler mentioned when he was giving four areas that he treated one above the clavicle. I would like to mention an experience I have had showing the systemic effect. I had an old lady with carcinoma of the glands above the clavicle and I treated her with anterior and posterior applications. She stood the erythema dose quite well. When she came in for her next series I thought I would get better results by aiming the rays down. That direction sent the rays right through the body, with the result that she was intensely sick. This shows the effect of raying a large part of the body in comparison with a small part of it.

An observation on the blood may interest you. A patient had his blood count done immediately before one hour's dose; he had 635,000 white blood cells. At the end of the hour of treatment another blood count was made and it was found that his white blood count had dropped from 635,000 to 135,000. Later on it dropped down to 13,000.

As to the question of divided doses, I think that until we know our technique we shall have to go on with divided doses.

Dr. Groover. About two years ago we called attention to certain lung changes which we had observed in treating patients for breast cancer. At that time we were using the following technique: 5 ma. current, 9 in. spark gap, 12 in. distance, and $^1/_2$ mm. Cu. and 1 mm. Al. filter, with exposure time of three hours. We stated at the time that in many cases we got a pretty severe skin reaction which, however, caused no serious inconvenience, but we were impressed with the regularity with which these lung changes appeared.

I merely wish to state at this time that we have abandoned that technique for that reason. We are now using the higher voltage apparatus, but have not used it a sufficient length of time to check up on the lung changes. However, we are thoroughly convinced that we can put a lung out of commission with much lower voltages.

I am very glad indeed to hear the men sound a note of warning as to the dangers of this so-called intensive treatment. I think that we should be cautious in the matter—not cautious to the point of cowardice, because we should remember that we are dealing with an otherwise hopeless malady, but we should at least attempt to balance our dosage to the patient's tolerance, which is not necessarily a question of skin tolerance.

Dr. Warren. Perhaps a word from the experimental side would be of value at this stage in the discussion. Most of our work has been done in California under Whipple, who has been studying intoxications of the nonspecific type. A discussion of the things which cause the intoxication following radiation would not sound well here.

One of the things we are continually concerned with is the intoxication following treatment of tumors with radiation. One of the chief symptoms which brings the patient with a tumor to you is cachexia. This is the result, supposedly, of degeneration of certain portions of the tumor which produces intoxicating substances. These bring about the condition in the body known as cachexia. If you radiate the patient and destroy the tumor, you throw more of these intoxicating substances into a circulation which is already overtaxed by these substances. You intensify the processes already going on, and as a result the patient becomes quite sick. A patient who has a carcinoma which is well advanced is quite susceptible to a very small increase of these substances, and therefore some of these effects are shown immediately. Other patients who are not so susceptible may not show these effects until degeneration of the tumor is well under way. Certain experimental intoxications are produced readily in dogs by radiation. If you give 350 ma. min. over the abdomen diffusely (we used 95 kv., distance of 10 in., using 2 mm. Al.) these dogs die on the fourth day. The symptoms start on the second day. This has been found to be constant in most of the series of animals available. As you go lower in the vertebrate scale the animals are more resistant. We thought this was due to the fact that the intestinal epithelium was highly organized and therefore less sensitive. The intoxication is explained upon the basis of the widespread destruction of the crypt cells in the intestinal epithelium. This destruction was very sharply limited to the small intestine from the pylorus to the ileocecal valve. This acute reaction to radiation can be found microscopically to start two hours after radiation and has been traced through up to the time of death at the end of four days. It is accompanied by a bloody diarrhea and prostration. Chemical and other investigations need not be discussed here but there is evidence that a profound tissue destruction has occurred. This is brought out on histological and anatomical study. (Warren & Whipple, *J. Exp. Med.*, 1922.)

Yesterday quite a bit was said about the destruction of capillaries by radiation. I do not think this is truly a primary radiation effect. In the first place, after a tumor has been radiated, the epithelial cells are killed. If you kill tissue in any portion of the body the pathologist will tell you that an ordinary inflammatory reaction will be brought about. The tissue coagulates and this brings about a hemorrhage in that region by rupture of the capillaries. Fibroblastic tissue is thrown out and the tissue is repaired. The same thing probably happens in the tumor. I do not know that this is strictly true in tumors but in our series of studies on animal tissue this is decidedly true in normal tissues. The intestinal lesions which can be produced with great regularity in dogs show thousands of small capillaries in the villi which are ruptured and thrombosed, secondarily to the destruction of the epithelium by the radiation.

There is another reason to suppose that the capillaries are not primarily influenced by radiation. The capillaries, fibroblastic cells and white blood cells are necessarily resistant to digestion. In all tissue repair these cells are concerned with migration into areas which have been destroyed, and which offer unfavorable environments for growth and life. These cells, therefore, must remain in the presence of degenerating tumors and injured areas and repair these areas. Antolysis studies have shown that these same cells are the most resistant in the body, and radiation seems to have no influence upon their rapidity of digestion or disintegration (Warren & Whipple—ibid).

Other cells, sensitive to radiation have been shown to autolyze much more rapidly than unsensitive cells.

With reference to repeated dosage, we have had several interesting leads. I am surprised that no one mentioned the article by Kingery (*Arch. f. Dermat. & Syph.*, 1920). A lot of these things get lost in the literature. He conceived the idea that the radiation effects decreased in accordance with the mass law. Therefore, if he repeated the dosage at a certain definite interval he could keep up the "saturation dose," in the tumor or skin. I say "saturation dose" with quotation marks because that is a poor name for the effect produced. He found that 50 per cent of an erythema dose could be repeated every three and a half days without an erythema. Obviously the skin is tremendously more resistant than the intestinal epithelium. Such factors as latent effects complicate the matter still more. One erythema dose in the dog is 75 ma. min., 95 kv., 2 mm. Al. filter, distance of 10 in. from skin to target. In human beings, using the same machine, 50 ma. min., under the same condition, was found to be an erythema dose. 75 ma. min., the E.D. for a dog definitely injures the intestinal tract. If we gave it all in one dose, 350 ma. min., over the abdomen, would kill the dog in four days. If this dosage is distributed over a period of a week, the dog will just survive no matter how the dose is divided up. If 350 ma. min. is distributed over more than a week, the effect noted will be in proportion to each individual dose only. Thus summation of the intoxication produced by destruction of intestinal epithelium could only be brought about by giving all the radiation within a week. This is further evidence in favor of the non-specific nature of the intoxication.

I was interested yesterday in the statement that in treating a tumor you should go after the ultimate tumor cells which were left after extensive radiation. We found that although you killed the dog after *x*-raying the intestines, you did not destroy all of the intestinal epithelium, but if you spread the dosage out over a period of a week or more you killed more and more of the intestinal epithelium. We thought that the intoxication after each radiation was due to absorption by the blood stream of toxic substances from the dead cells. The dog would go through the symptoms following one dose and then recover. There was no increased sensitivity or anaphylactic reaction to the second dose. It was a purely chemical phenomenon.

We have had a small amount of experience with secondary radiation. We used lead screens with a one- or two-inch aperture, square, or circular, as the case might be. Using intestinal epithelium as an indicator, we gave 7 or 8 erythema doses over this small area. The dog had a small amount of diarrhea and at autopsy there was definite ulceration of the intestine which was sharply limited to the area that was exposed to the rays through the aperture. We think, therefore, that secondary radiation which may be effective in the destruction of sensitive tissues is not a factor which necessarily has to be considered in therapy. I know there are a lot of physicists who will not agree that secondary radiation is not effective, but at least by this method we cannot demonstrate any effect in the tissues at any appreciable distance from the area which has been exposed in the primary beam.

We have had no experience whatever with the effect of high voltage radiation upon the pleura, but we have used tremendous doses at 95 kv. over the thorax and we have obtained no lesions except skin burns and changes in the white count and bone marrow. Very often those cases in which pleural fibrosis is present are complicated by carcinoma. Carcinoma is well known to produce fibrosis and also exudate in the pleural cavity. It is probable that the fibrosis noted is due to the cancer and not to the radiation. More experimental work must be done on this subject to clarify this point.

There is another consideration which I think the average man does not think of, and that is, how often he exposes the abdomen without taking into consideration the fact that his rays may penetrate through the abdomen. We have looked with great respect upon the intestinal tract, and every time there is any chance at all for the radiation, even at a great distance, to penetrate the abdominal region, we suspect—or we should suspect at least—that the intestinal tract has been injured to some extent, causing some symptoms of intoxication without producing any clinical evidences of such an injury. When a patient has been radiated and the intestinal tract is in the field, even though very far distant, we must rule out that particular element when talking about intoxications.

Dr. Pfahler (closing discussion). I appreciate this discussion very much. I purposely made the paper brief so that we could have it. I did not attempt to discuss all the phases that might have been considered.

First, with reference to the dose: I, of course, do not think there is any fixed dose for carcinoma. Many of you have gotten the impression that in Europe these men who speak of a carcinoma dose think there is some fixed percentage of an erythema dose that will kill all cancer. I am quite sure you are wrong. At least, that has not been my observation. They simply take that percentage as a general plan of action.

I agree thoroughly with Dr. Sittenfield that we must adapt our technique and dosage to each individual case, and must consider first of all the patient's general condition and general health. We must not kill the patient while curing the disease, and for that reason, as you will see by the few cases I referred to, we do not attempt to give all the treatments in one day, but spread them over a period of ten days to two weeks. You will see by the few cases that I have referred to (and I can refer to others), that we do not attempt to cure the case by a single application. Every one has had from three to five applications over the diseased area, and so you see that we have really delivered into that tissue from three to five times the amount that we might think necessary to cure the disease. I am quite sure that in many cases we are not curing them, no matter how much we carry into the tissue. We all observe, clinically, in carcinoma, that there is a great variation, and we must meet that variation with the maximum amount of radiation that we can deliver into the diseased tissue. If we can know just where the diseased tissue is located and confine our cross-firing as much as possible to that diseased area, we will do much for the patient. But unfortunately, especially in carcinoma of the breast, we get metastasis at great distances, and at the best we cannot plan to treat further than the mediastinum in the first treatment.

Now as to the blood: We must be very careful about the blood. In every case that we treat with high voltages we start with a complete blood count, so that we know the condition of the blood at the start. If it is not up to normal, we do everything that is possible to bring it up to normal. The blood must be watched during the course of treatment because the treatment does tend to decrease both the reds and the whites. The rapid decrease to which Dr. Pirie referred is a question that has not yet been solved. Of course, he starts with an extremely high white count, and of course that will respond much more readily than normal blood.

Now as to technique: We are not using the same general technique in every case, but we should have something to start with. I gave you just a general plan of action, but by no means should you confine yourself to that. You must adapt your technique to the individual case. If you know where the diseased tissue is, and can confine your radiation to that diseased area and are sure there is none beyond, you are better off for the sake of the patient. You cannot send radiation through normal tissue without some effect on it.

With reference to lung changes: I have been studying the chests of patients I have been treating routinely during the past twelve years. I make a plate at the very beginning of treatment and make repeated plates during several years following this treatment. I have also been noticing these fibrotic changes developing in the lungs. Not in the great majority—I should say perhaps 10 per cent—but in every instance when I take this series of plates running back over several years in which I observed these fibrotic changes, I have been able to trace the beginning of it even before I gave the first application. If you look carefully, you can trace back and find the very beginning of the fibrotic change before you start. We are probably stimulating it in some way. For a time I thought the changes were a fibrous process replacing malignant disease. I do not know what it is.

I am much interested in Dr. Warren's statement that he has not observed these changes in dogs. We must bear in mind that they do not come quickly. They may come six months, a year or two years after treatment. Therefore, it may be that he has not observed the dogs long enough to get the fibrous changes. I do not think these changes should deter further treatment.

With regard to setting up a pleurisy, I will give you a single experience which I have had in the past few months. Patient was referred to me by Dr. Babcock; she was tapped on two occasions for pleural effusion, left lung, following carcinoma of the left breast, before coming to me. I made an *x*-ray examination and found further evidence of fluid. I did not want to start treatment until the fluid was removed. This was done and I made another examination, and found half of the lung area opaque. I think it was undoubtedly due to tumor tissue. I treated that patient with high voltage in the manner which I have described. The tumor tissue has undoubtedly decreased, the patient's general health has improved, and the fluid has not recurred.

Now as to toxic effects: That is a subject we could spend a whole day discussing and then not decide. I regret exceedingly that Dr. Case did not come and give us his paper. I have been studying this subject of radiation sickness for a number of years and have had such contradictory evidences that I do not know where I stand.

I have referred to this one case before in discussion, but I mention it again because it is so peculiar. Patient was treated for fibroid of the uterus and was given 16 portals of entry at that time. During the first course of treatment she had no radiation sickness. Then she developed sickness and I finally gave her only one dose on each day. When she came back for the third or fourth course of treatment she said she wanted the treatment all in one day—wanted to be sick all in one day and get it overwith. So I gave her 16 doses, and she did not get sick a bit. How are you going to explain it? We run into such contradictory evidence all the time. Sickness does not always come from the abdomen. I have had serious radiation sickness when treating about the face where the rays were sent down through the body.

I was very much interested in the observations of Dr. Warren that ulcerations were confined to the area treated. That would indicate, in my judgment, that the radiation sickness is not due to degeneration of the intestinal epithelium, because the damaged epithelium is confined to the actual location of the rays, and therefore it is not due to any secondary effect from circulating blood changes. I know you will find in the literature that some of the European workers have assumed that the radiation sickness is due entirely to effect on the intestinal epithelium. Of course you observe epithelial changes from massive doses for carcinoma of the uterus because you are sending the rays through that area, especially where you are using large fields, but I think it is entirely wrong to assume that radiation sickness is entirely due to that effect. There must be something else we have not yet discovered.

A SIMPLE NOMOGRAM FOR THE DETERMINATION OF RADIUM SKIN DOSES

BY EDITH H. QUIMBY, M.A.

Radium Research Laboratory, Memorial Hospital

NEW YORK CITY

In a previous paper,[1] an equation was published whereby if five of the six conditions determining radium dosage—milligrams of element, time of exposure, distance of source from skin, amount of filtration, and size and shape of applicator—were known, the sixth could be calculated. The equation is

$$\text{S.D.} = \frac{0.63 \times (\text{mg.} \times \text{hr.}) \times \alpha \times \delta}{(\text{cm.})^2}$$

S.D. represents the amount of radiation falling on the skin, measured in terms of the standard erythema dose; α, a factor which takes account of the filtration; δ, one depending on the size and shape of the applicator and its distance from the skin; mg., hr., and cm. are self-explanatory. A table of values for α was published in the same paper, and tables and curves for finding the value of δ for any applicator, in a later one.[2] It remains, then, only to substitute the values in the formula and perform the indicated operations.

It occurred to the writer that a simpler means of solving this equation would be a nomogram, or chart, on which, when the points representing the known quantities were connected by straight lines, the solution would be immediately indicated. Such a chart can be constructed for an equation of this type with any number of variables, but the simplest form is for four. We may reduce the number of variables in our equation to four by combining milligrams and hours into milligram-hours, and by deciding that we will make a separate chart for each filtration factor, thus reducing α to a constant for the special case. In practice, only a few filters are used, and it is more convenient to have a chart for each one than to use the more complicated nomogram for five variables.

---

[1] Failla, Quimby, and Dean. Some problems of radiation therapy. Am. J. Roentgenol., August, 1922.

[2] Quimby. The effect of the size of radium applicators on skin doses. Am. J. Roentgenol., October, 1922.

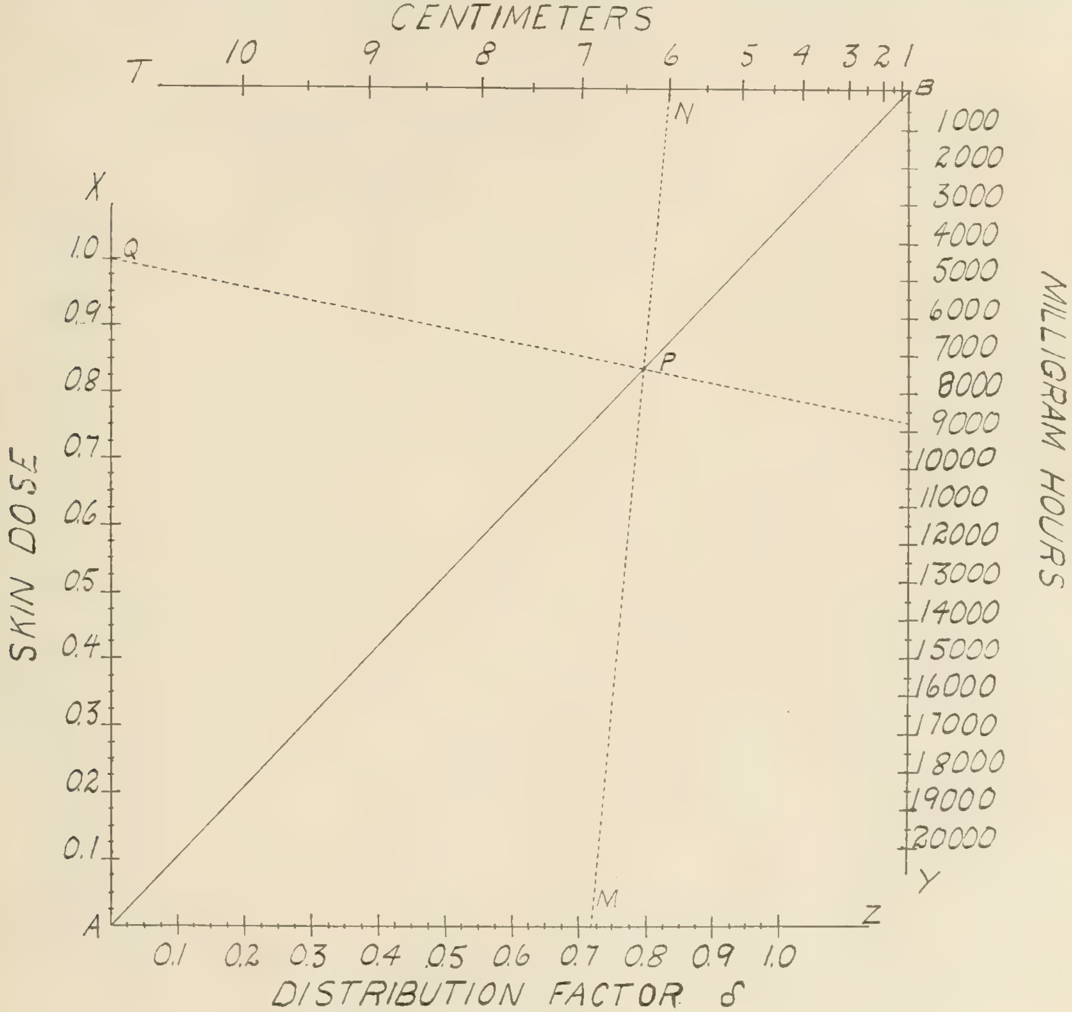


FIGURE I

Filter 2 mm. Brass and 2.4 mm. Rubber

If we consider the special case of a filter of 2 mm. of brass and a few mm. of rubber, in which we are most interested, as the standard for gamma ray therapy, α becomes 0.009, and our equation is

$$\text{S.D.} = \frac{0.63 \times 0.009 \times (\text{mg.-hr.}) \times \delta}{(\text{cm.})^2}$$

The nomogram for this equation, constructed by the regular method (see "Graphical and Mechanical Computation," by Joseph Lipka) is shown in Figure 1. The scales AX, BY, AZ, and BT represent skin dose, milligram hours, distribution factor, and distance respectively. The diagonal AB is necessary in using the chart, and the dotted lines represent a solution of the equation, and will be discussed later. Figures 2 and 3 are similar nomograms for filtrations equivalent to 0.5 mm. of brass and 1.2 mm. of rubber, and 0.16 mm. of brass and 1.2 mm. of rubber (α equals 0.03 and 0.25 respectively).

The method of using these is as follows: Three of the variables in the equation are known, and it is desired to find the fourth.

Between the values of the two known quantities which occur on opposite scales—S.D. and mg.-hr., or cm. and δ—draw a straight line. Connect the point where this line crosses the diagonal AB with the point on the scale representing the third known quantity, and extend this line to the fourth scale, which it will intersect in the point giving the desired value. A few illustrations will make this clear. Values for δ for any applicator at any distance may be found by means of the paper previously mentioned. A few of those most used are given in Table I.

1. With an applicator 8 × 12 cm., having a filtration equivalent to 2 mm. of brass and 2.4 mm. of rubber, it is desired to give one skin dose at a distance of 6 cm. What amount of radiation is necessary? The solution is indicated in Figure 1. The distribution factor, δ, for such an applicator is 0.719. The line MN joins this point on the δ scale with 6 on the centimeter scale, and intersects the diagonal AB in P. The line QP connects this point with 1 on the skin dose scale, and, extended, cuts the milligram hour scale at 8,800, which is the dose required.

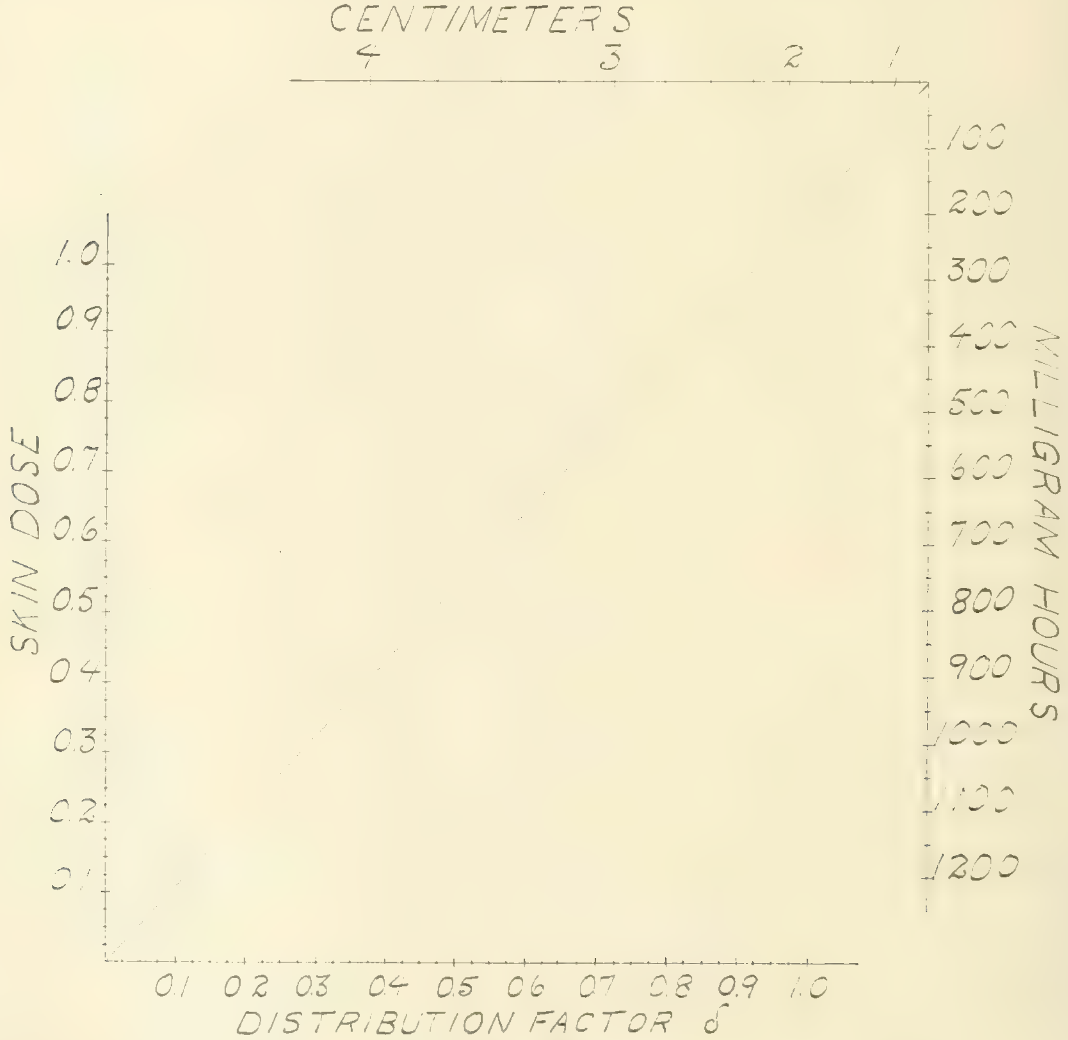


FIGURE 2

FILTER 0.5 MM. BRASS AND 1.2 MM. RUBBER

2. What will be the intensity of radiation delivered on the skin by a 4 cm. square plaque having a filtration equivalent to 0.16 mm. of brass and 1.2 mm. of rubber, when a dose of 25 mgm. hrs. is given at a distance of 2 cm. from the skin? The solution is indicated in Figure 3. δ from the table is 0.462, and the line MN joins this point with 2 on the centimeter scale. PR joins the intercept on the diagonal with 25 on the milligram hour scale, and, extended, cuts the skin dose scale at 0.475, which is the portion of a full skin dose delivered on the skin.

In practice it is convenient to copy these nomograms accurately to scale on a piece of cardboard or stiff paper, and use tracing paper on which to mark the index lines for solving the equation. In this way the chart itself will not be disfigured.

The accuracy of the solution obtained in this way depends on the accuracy with which the scales are made and the care with which the index lines are constructed. It should be easy to get results correct to within 2 per cent, which is much better than actually needed in radiation therapy.

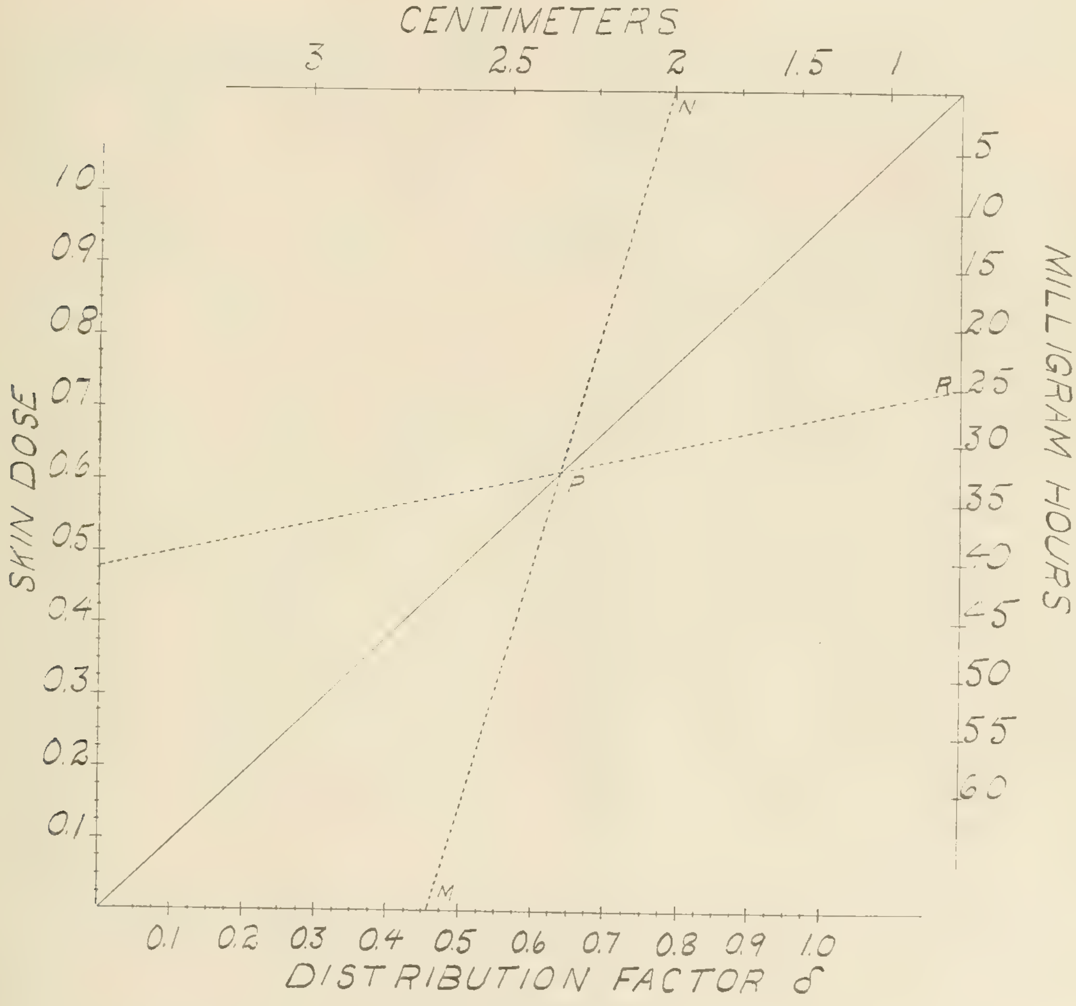


FIGURE 3

FILTER .16MM. BRASS AND 1.2MM. RUBBER

TABLE I

DISTRIBUTION FACTORS FOR CERTAIN APPLICATORS AT DEFINITE DISTANCES

1. Filter 0.16 mm. Brass and 1.2 mm. Rubber

Distance, centimeters	Circles (diam.)		Squares (side)		
	2 cm. δ	4 cm. δ	1 cm. δ	2 cm. δ	4 cm. δ
0.5	0.196	0.054	0.462	0.178	0.050
1.0	0.504	0.196	0.761	0.462	0.178
2.0	0.781	0.504	0.925	0.761	0.462
3.0	0.889	0.692	0.963	0.872	0.654

2. Filter 0.5 mm. Brass and 1.2 mm. Rubber

Distance, centimeters	Circles (diam.)		Squares (side)		
	2 cm. δ	4 cm. δ	1 cm. δ	2 cm. δ	4 cm. δ
1.0	0.495	0.223	0.752	0.460	0.210
2.0	0.788	0.495	0.905	0.752	0.460
3.0	0.877	0.685	0.953	0.860	0.660

3. Filter 2.0 mm. Brass and 2.4 mm. Rubber

Distance, centimeters	Circles (diam.)		Squares (side)			Rectangles		
	2 cm. δ	4 cm. δ	2 cm. δ	4 cm. δ	6 cm. δ	4 × 6 cm. δ	6 × 9 cm. δ	8 × 12 cm. δ
2.0	0.887	0.685	0.840	0.635	0.478	0.552	0.388	0.283
3.0	0.947	0.827	0.936	0.775	0.635	0.719	0.552	0.430
4.0	0.970	0.887	0.955	0.840	0.711	0.808	0.668	0.552
5.0	0.980	0.927	0.973	0.898	0.800	0.863	0.755	0.639
6.0	0.986	0.947	0.979	0.936	0.840	0.901	0.808	0.719
7.5	0.992	0.966	0.986	0.951	0.898	0.937	0.863	0.790
10.0	1.000	0.980	0.990	0.973	0.939	0.962	0.919	0.863

ROENTGEN THERAPY IN THE TREATMENT OF NASAL POLYPI*

BY JAMES G. WARE, M.D.

SANTA BARBARA, CALIFORNIA

DURING the past two years, I have had the opportunity of treating 16 cases of nasal polypi by roentgen therapy. The results have been so favorable that I felt sure the report of a few cases might be of interest, not only to those specializing in *x*-ray work, but to the members of the profession in general.

Under certain conditions, purulent sinus inflammations will give rise to the formation of myxomata or edematous nasal polypi. They are usually associated with inflammatory changes in the sphenoid cells; less commonly with the ethmoids and maxillary antra. They usually spring from the sphenoidal ostium or the ostium maxillare, and occasionally from the middle turbinate or ethmoids. On rare occasions one may be observed attached to the nasal septum. They are rarely seen in persons under the age of puberty.

Nasal polypi are usually fibromyxomata, being composed of edematous mucous membrane, containing the usual inflammatory products. A covering of epithelium surrounds the sac and is supplied by a few blood-vessels and nerve filaments. They may be single, multiple, pedunculated or sessile. They may be large enough to fill the entire nasal chamber, or extremely small, appearing like a cluster of minute grapes.

The patient usually complains of nasal obstruction and watery discharge, or may have occasional attacks of acute rhinitis. Headaches, asthma and attacks of sneezing are not uncommon. The quality of the voice is changed, due to the obstruction of the nasal passage.

Surgical intervention is not always successful, the polypi recurring times without number.

The treatment of polypi by roentgen rays follows closely the technique employed first by Witherbee in the treatment of tonsils. The following factors are used: 3 mm. of aluminum; 8-in. sp. gap; 5 ma.; 10-in. distance; four min. to each side. Four to six treatments at one-week intervals. Rays are directed over the nose and up into the posterior sinuses, through an opening in a sheet of lead foil, approximately 2½ in. in diameter. The head is slightly turned to one side as each dose of four minutes' duration is given.

It is always advisable to make an *x*-ray examination of the antra before beginning treatment. Not infrequently nasal polypi will be associated with multiple polypi of the maxillary antra, the plates showing a marked density of these sinuses. Treatment of the nasal polypi alone will give very little relief. My experience leads me to believe that if the polypoid growths in the antra are surgically removed, followed by *x*-ray treatment, excellent results will be obtained.

CASE I. Female, aged forty. States that for the past ten years she has had multiple polypi removed from both nares on several occasions. She has had periodic nasal discharge, associated with headaches, and general feeling of malaise. Both sides of the nose are partially obstructed at this time by similar growths. Patient was given two doses of *x*-rays, one week apart. There was a rapid shrinking of the polypi. Patient states that discharge has practically stopped and that she can breath without difficulty through the nose.

CASE II. Male, aged thirty-nine. Four years ago had an infection of all the accessory nasal sinuses. Following that time has had persistent nasal discharge. Discharge suddenly stopped and patient began to complain of headaches and difficulty in breathing through nose. Large polyp formed on left side. Smaller ones were found in right nares, apparently attached to ostium of sphenoid. Were surgically removed. Discharge increased and headaches stopped. Within six months symptoms began to reappear, and polypi reformed. Again they were surgically removed. The following year his symptoms were worse than at any previous time. Examination showed large polyp in left nostril, and multiple small ones in the right. Was given four doses of *x*-rays at one-week interval, and condition began to improve immediately. Polypi have entirely disappeared and he has had no recurrence of symptoms.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1922.

Case III. Female, aged forty-five. Referred for *x*-ray examination of teeth. In making these films, I observed that patient was breathing entirely through the mouth. Closer observation showed that a large polyp filled the entire left nostril, and was almost protruding. The right side showed no evidence of polypi, but the turbinates were greatly thickened and the septum deflected to the right. When asked if she would allow me to treat this condition in order that I might follow up my work in this line, she informed me that she had had them surgically removed on several occasions, but that they had always recurred, and that now she was taking up Christian Science. I told her that I hoped she would improve under this form of treatment, but that if she wanted to come back at any time for treatment I would be glad to do what I could for her, purely from an experimental standpoint. She returned in two months, unimproved. Four doses of *x*-rays were given. Improvement was almost immediate. The polyp disappeared and the congestion of the turbinates on the opposite side lessened. I advised her to consult a specialist to have the septum corrected, but she preferred to leave "well enough" alone.

Case IV. Male, aged fifty-two. Presented himself as an experimental subject. Has been troubled for eleven years with chronic sinus infection, involving the ethmoies and sphenoids, associated with the formation of multiple small polypi in the upper nasal chamber. Had been operated on several times with temporary relief. Examination showed the presence of multiple minute clusters of polypi high up in the nasal cavity of both sides. Patient was given three doses of *x*-rays one week apart. Relief was rapid. The discharge was markedly increased after the first dose, but began to subside rapidly. His headaches disappeared, and his general health was greatly improved. There has been no recurrence up to this time, after a period of eight months.

The remaining cases were all of the same type. Four treatments, one week apart, are usually sufficient, but as many as six have been given. Several cases have been lost track of, but it seems probable from those that can be observed, that all will undoubtedly obtain considerable relief. It is too early to predicate the final outcome, but we hope that the results will be permanent.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.

Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.

Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

HOME-MADE *X*-RAY DIAGNOSIS

So much has been said and written in the past few years about the benefits and evils of specialization in medicine that one is apt to take it for granted that the entire trend of medical thought and action has been in the direction of closer limitation of the specialties, with even further subdivision of already marked-off special fields. It is of interest therefore to detect and comment on one example of an opposite tendency; a tendency for members of various special groups to take over the functions of an already well-recognized and well-established special medical field.

A prominent manufacturer of *x*-ray equipment advertised not long since, in effect, that *x*-ray equipment is now as simple to operate as a typewriter and quite as necessary to the office of the modern physician. The invention of the Coolidge *x*-ray tube, an entirely reliable and dependable source of *x*-rays which has supplanted the temperamental gas tube of former days, and the post-war simplification of *x*-ray apparatus in general have indeed removed most of the mystery and complexity from the technical side of *x*-ray work. It is possibly quite true that an intelligent person, with the general education and the special training in physics, chemistry, and anatomy which every well-trained physician possesses, could learn more easily to make satisfactory routine roentgenograms than to type a neat letter in a reasonable length of time. It is also perhaps in the nature of things to be expected that the manufacturer of equipment should not see beyond the production of roentgenograms, since he is not concerned with better medicine, nor even, directly, with better roentgenograms, but rather with more of them.

There is, however, another and not too obscure goal beyond the roentgenograms, and that goal is diagnosis. If the aim of roentgenography is diagnosis, the question becomes, not who makes the roentgenogram, but rather who interprets it. Roentgenologists have for years voiced earnest and strenuous objection to the interpretation of *x*-ray findings by lay technicians, and not by any means entirely for selfish reasons, but rather because they felt that such a practice had a tendency to discredit their own work in the minds of the not too discriminating members of the medical public, as well as of the lay public. The very ease of operation of present-day small roentgen equipment begins to justify similar criticism of what may perhaps be called the medically-trained *x*-ray technician, the medical man who feels competent to interpret his own *x*-ray films because he has purchased an *x*-ray machine.

No criticism is intended of the man so situated that he must perforce be his own roentgenologist. He deserves all credit for his progressive spirit and his resource. Nor is it intended to criticize the surgeon who prefers to *x*-ray his own fracture cases, and who has had a sufficiently wide experience to feel perfectly capable of reading bone films. The simplified *x*-ray equipment of today enables both these classes of medical men materially to improve the quality of service they render their patients, and that is after all, the only criterion by which any development in medicine ought to be judged.

In another and perhaps increasingly common application, the wider distribution of *x*-ray equipment has lowered the quality of service rendered the patient. I refer to the man doing a large practice in a more or less specialized medical field in an urban community with no dearth of trained roentgenologists, who for his convenience and immediate profit elects to do his own *x*-ray work. It is easy to follow the train of thought which leads to such action. The internist or the orthopedist or the surgeon finds himself increasingly busy, with more and more demands on his time, and perhaps on his pocketbook. The unavoidable delay and loss of time incurred in sending patients for examination even to a neighboring roentgenologist becomes increasingly irksome. It strikes him that he is sending out an average of three or four cases a day. He has been in the habit of viewing *x*-ray films with his roentgenologist for years, and feels that he has picked up enough knowledge of interpretation. It is pointed out to him that the apparatus necessary to make his own plates would not take up a great deal of room, that a convenient closet can be made into a dark room, that his office nurse can be taught technique, and that the equipment "will pay for itself" in six months, more or less. Looking at it in that light the wonder is that every man in large practice does not install his own roentgen equipment. And if he looked on medicine solely as a business, perhaps he would. Certain it is that this line of reasoning appeals to many men who otherwise remain strictly within the limits of their special field; to internists who, for instance, would not think of doing their own tonsillectomies.

Such a course, attractive as it may seem, has two serious pitfalls. The first and most obvious is that the internist or the orthopedist or the surgeon does not really know enough about *x*-ray interpretation to do justice to his patients. Those examined by him are *x*-rayed, but they are not given the full benefit of an *x*-ray examination. Further, this situation is not one that is apt to improve materially since, the man who has thus taken over the functions of his roentgenologist is almost certainly too busy with his regular and proper work really to learn roentgen interpretation. Such a course would imply a willingness and an ability to take his mind and his time away from the work to which he has devoted years of thought, and focus his attention on another and alien specialty.

However, granting this adequate and unusual knowledge of roentgen interpretation, home-made *x*-ray diagnosis is dangerous in another and more subtle way. However well we may have been taught to maintain an open mind during the progress of an examination, however often we may have been warned not to make a snap-shot diagnosis and then seek to confirm it by further examination, it is almost impossible for the clinician to avoid forming a definite opinion from the history and the physical examination, and it is more than human for him not to hope that other and later evidence will tend to support him in his guess. An *x*-ray examination, in any obscure condition, to be of real value, should be a roentgen consultation, and should have all the scope and all the honesty of any other consultation. If it is allowed to become either a conscious or an unconscious effort to confirm a clinical impression, it has already lost much of its value. The suggestion that such molding of *x*-ray findings to accord with the clinical picture is of frequent occurrence, does not by any means imply a lack either of honesty or ability on the part of the interpreter. It is obvious that this will not occur in cases where the *x*-ray evidence is clear-cut and convincing and of a positive character. The shadow of a kidney stone, for instance, or of a group of gall-stones when clearly shown, and proved to be such, admits of no misinterpretation. Similarly, advanced tuberculosis, fluid in the chest, and advanced bone pathology all give clear-cut *x*-ray indications too frank to be disregarded or greatly distorted by any one trained in roentgen interpretation. The temptation to pervert the evidence, or rather to allow the clinical bias to play a part in dictating the interpretation of *x*-ray findings occurs only in the border-line conditions where men might honestly differ as to the interpretation to be put upon a film or a fluoroscopic examination. Frequent examples are early lung changes, gall-bladders which are capable of *x*-ray demonstration but which do not show stones, early joint and spinal disease, and minor changes in sinus densities. In each of these instances, if the clinician makes his own *x*-ray examination he is rather prone to bend the interpretation to fit his clinical impression, and then, possibly in all honesty, to say that the clinical diagnosis was confirmed by *x*-ray examination. How ridiculous and how unfortunate for the patient.

Another and perhaps the most common field for this unfortunate type of interpretation is the roentgen surveys of the gastrointestinal tract. Here much of the evidence is necessarily indirect, and when so, its value depends almost entirely upon the experience and ability of the roentgenologist. If he is to arrive at true conclusions it is highly desirable that he conduct his examination without any clinical bias whatever. If, when he has finished, his report confirms the impression gained from the history and the physical and laboratory findings, well and good; the case is made so much stronger. If, on the other hand, it quite fails to accord with these impressions, this disagreement should give the clinician pause; should lead him to scrutinize with due care his own findings to see whether they justify him in disregarding the roentgen evidence.

If the *x*-ray examination, then, is to be anything more than a gesture, if its object is really to throw additional light upon the obscure and difficult case, if it is to do something more than impress the patient with the completeness of the doctor's equipment, it seems highly desirable that it should be, at least in all except the simplest cases, truly a roentgen consultation conducted by a competent specialist who devotes his entire attention to roentgenology, and who has the courage and ability to give a worth-while opinion based upon *x*-ray evidence alone, and not biased either consciously or unconsciously by laboratory or clinical factors.

Charles D. Enfield.

Louisville, Ky.

REDUCED RATES

The attention of roentgenologists living on the Pacific Coast is directed to the following letter from the Chairman of the Trans-Continental Passenger Association:

Dr. A. C. Christie, Business Manager,
American Roentgen Ray Society,
Washington, D. C.

Dear Sir:

Referring to the question of excursion fares from Pacific Coast states for the next meeting of the American Roentgen Ray Society, Chicago, Illinois, September 18–21, 1923:

The question of fares for delegates from Pacific Coast to conventions and meetings to be held in eastern territory between the latter part of May and the middle of September, 1923, has been given consideration and it has been definitely determined to authorize the sale of summer excursion tickets at fares slightly higher than the one-way fare for the round trip.

The fares which will apply from principal points are as follows:

To Chicago

From San Francisco, Calif.	$86.00
Los Angeles, Calif.	86.00
San Diego, Calif.	86.00
Portland, Oregon	86.00
Seattle, Wash.	86.00
Spokane, Wash.	81.00
Tacoma, Wash.	86.00
Vancouver, B. C.	86.00
Victoria, B. C.	86.00

Fares shown herein are subject to change without notice.

The summer excursion tickets will be on sale May 15 to September 15, inclusive, limited for return to October 31, 1923. Stop-overs will be permitted at all points on the going and return trip.

Summer excursion fares and arrangements will be available to delegates and visitors attending your convention.

Attention is invited to the fact that these fares are lower than the general convention basis and should encourage and stimulate travel to your convention as well as general travel.

It is recommended that delegates to your convention confer with their home ticket agents who will be able to give them more detailed information regarding fares, routes, attractions, etc.

In addition to the above letter, further announcement is as follows:

To all parts of the United States and Canada, except the Pacific Coast States, a reduction of one and one-half fare on the "Certificate Plan" will apply for members attending the meeting of the American Roentgen Ray Society to be held at the Congress Hotel, Chicago, Illinois, September 18–21, 1923, and also for dependent members of their families.

The following directions are published for the guidance of members who wish to obtain the reduced rates:

1. Tickets at the regular one-way tariff fare for the going journey may be obtained on any of the following dates (but not on any other date): September 14–20. Be sure that, when purchasing your going ticket, you request a CERTIFICATE. *Do not make the mistake of asking for a "receipt."*

2. Present yourself at the railroad station for ticket and certificate at least thirty minutes before departure of train on which you will begin your journey.

3. *Certificates are not kept at all stations.* If you inquire at your home station, you can ascertain whether certificates and through tickets can be obtained to place of meeting. If not obtainable at your home station, the agent will inform you at what station they can be obtained. You can in such case purchase a local ticket to the station which has certificates in stock, where you can purchase a through ticket and at the same time ask for and obtain a *certificate* to the place of meeting.

4. Immediately on your arrival at the meeting present your certificate to the endorsing officer, Dr. A. C. Christie, Business Manager, as the reduced fare for the return journey will not apply unless you are properly identified as provided for by the certificate.

5. Arrangements have been made for validation of certificates by a Special Agent of the carriers on September 18–21 if the required minimum of 250 certificates is presented.

6. *No refund of fare will be made on account of failure to obtain a proper certificate, nor on account of failure to have the certificate validated.*

7. So as to prevent disappointment, it must be understood that the reduction on the return journey is not guaranteed, but is contingent on an attendance of not less than 250 members of the organization at the meeting and dependent members of their families, holding regularly issued certificates obtained from ticket agents at starting points, showing payment of regular one-way tariff fare of not less than 67 cents on going journey.

8. If the necessary minimum of 250 certificates is presented to the Special Agent as above explained, and your certificate is duly validated, you will be entitled up to and including September 25, 1923, to a return ticket via the same route over which you made the going journey, at one-half of the regular one-way tariff fare from the place of the meeting to the point at which your certificate was issued.

9. Return ticket issued at the reduced fare will not be good on any limited train on which such reduced fare transportation is not honored.

EXHIBIT OF FILMS AND LANTERN SLIDES

The Committee on Scientific Exhibition for the Chicago meeting is desirous that a very large film and lantern slide exhibit be made this year, and hopes that members will send in films or slides of their interesting cases together with complete histories. The space available is such as to make the exhibit this year unusually attractive. The chairman of the committee is Dr. Edw. S. Blaine, 5 So. Wabash Ave., Chicago, Ill. All correspondence concerning the space desired should be directed to him. Films should be shipped direct to the Congress Hotel, marked in care of the Committee on Scientific Exhibition.

Dr. Hickey also requests that as many members as are able should send in films and reports covering bone sarcoma, bone syphilis or Perthes' disease. These should be addressed to the hotel in care of Dr. Hickey.

TRANSLATIONS & ABSTRACTS

Richardson, Edward P. Relative value of surgery and roentgen rays in the treatment of hyperthyroidism. *J. Am. M. Assn.*, Mar. 24, 1923, lxxx, 820.

This paper is a combination contribution from the surgical service, the roentgen-ray department and the medical laboratories of the Massachusetts General Hospital. The measures yielding the best results in hyperthyroidism are surgery and irradiation. In the Massachusetts General Hospital, a series of cases of hyperthyroidism treated by the roentgen ray was begun by Holmes in 1914. The results of the treatment were reported by Holmes and Merrill in 1919. From the same clinic, Means and Aub, using the basal metabolism as an index of intoxication in exophthalmic goiter, compared the effect of treatment by roentgen ray with that by surgery. The results obtained in hyperthyroidism by irradiation with the roentgen ray were felt by the committee chosen from the various services to direct the treatment of the thyroid cases, to be sufficiently encouraging to justify a continuation of this form of treatment in selected cases. At the same time the committee believes that roentgen-ray treatment should be limited, as stated by Holmes and Merrill, to cases which show symptoms apparently due to increased function of the gland, such as increased metabolic rate, rapid heart action, nervousness, loss of weight and weakness. Goiters with normal or reduced function, requiring treatment for deformity, pressure on adjacent structures, potential malignancy, or potential hyperthyroidism, should be treated by surgery and not by roentgen rays. The only exception to this is in malignant goiter beyond reasonable hope of benefit from operation. Here the roentgen ray has an important rôle. Beyond this, the roentgen ray is not a treatment for goiter; it is a treatment for hyperthyroidism.

Aside from accurate diagnosis there are certain other essential conditions without which roentgen-ray treatment should not be undertaken. The first is adequate modern roentgen-ray equipment, with ability to measure dosage. The second is means of estimating the degree of benefit obtained by determination of the basal metabolism as well as by clinical observation. Without this, a slight degree of persistent hyperthyroidism demanding further treatment may be continued when there is danger of myxedema. The third is careful and accurate clinical supervision. An open mind should be kept in regard to switching to surgical treatment, if improvement is not rapid and complete. It has not proved possible to predict the effect of the roentgen ray in any given case. Means and Holmes are unable to show that either the age of the patient or the intensity of the hyperthyroidism, as shown by the level of the metabolism, is a factor determining the success or lack of success of roentgen-ray treatment. An impression that recent cases in young persons were more responsive to the treatment was not borne out by their statistical study. There are, however, certain cases in which the roentgen ray seems unsuitable. Among these are adenoma with hyperthyroidism. Here the cause of the symptoms seems to be within the thyroid gland, and not only is it logical to remove this cause surgically, but the late results of operation are better than in exophthalmic goiter. If the roentgen ray is used in these cases, it should be as an adjuvant to the effect of preliminary ligation of the thyroid arteries.

If surgery is more effective in the average case, why should the roentgen ray be used at all? Surgery is a clumsy form of treatment for a gland that is hyperactive. In exophthalmic goiter, the ultimate cause of the disease is unknown. By removing part of the gland we are not affecting the cause; we are merely removing part of a gland that is excited to hyperfunction. The changes accompanying hyperfunction are still present in the part of the gland that remains. The amount of the gland left to maintain thyroid function is purely a guess on the part of the operator. When surgery can safely accomplish removal of a proper proportion of the gland, it has reached its limit. The roentgen ray, on the other hand, while also acting as a destructive physical agent, has nevertheless the possibility of indefinite expansion as a means of treatment. Improvements in technique and manner of application may lead to results as yet unobtained. It shows sufficient promise to be given opportunity. Certain minor advantages have been claimed for roentgen-ray treatment. These are absence of operative scar, sparing the patient the distress and discomfort of going through operative procedures, and the fact that hospitalization may not be necessary. Although these advantages loom large in the minds of patients, hyperthyroidism is a sufficiently serious condition in its immediate and remote effects to make these advantages deserving of slight consideration in advising treatment.

The chief advantage of the roentgen ray is that its immediate mortality is nil. The use of the roentgen ray in the Massachusetts General Hospital is undoubtedly influenced by the fact that the mortality in the cases of hyperthyroidism treated surgically since the organization of the thyroid committee has been 7.1 per cent. There have been five deaths among 70 patients, in some of whom the surgical program is as yet incomplete. The surgical aspects will be presented later in detail. While the mortality from surgery reported from certain large clinics is small, this would probably not be true of small series and isolated cases compiled throughout the country. The stage of gaining experience in this condition is likely always to result in mortality. It must be remembered that mortality is often figured from the number of operations, not from the number of patients treated, and that figures may combine toxic and nontoxic cases.

It has been said that recommending the roentgen ray has done harm. It is also true that unqualifiedly recommending operation on the diagnosis of exophthalmic goiter may do harm. The roentgen ray will accomplish the "cure" of a certain percentage of cases. In others it will bring about a degree of improvement that will permit of safer operation, or make unnecessary some of the preliminary operative steps. It is an additional weapon in the treatment of hyperthyroidism. The question is how and when to use it.

Many objections have been raised to roentgen-ray treatment. The chief of these is the temporary relief afforded. While it is true that in certain cases there is a tendency for the metabolism to rise after a period within normal limits, these are a small minority. In these, as a rule, roentgen-ray treatment results in a second drop, to the normal metabolic level. On the whole, the results in cases brought to within normal metabolic limits seem satisfactory.

A second objection is the occurrence of myxedema. Means and Holmes report that since the beginning of the roentgen-ray treatment at the Massachusetts General Hospital, 4 patients have developed myxedema. Two developed it within the first four months of roentgen-ray treatment. In both, the depression of metabolism proved temporary. One patient developed myxedema eighteen months after roentgen-ray treatment; another, five years after. Whether in these cases there is any actual connection between the treatment and the myxedema is uncertain. It seems that the danger of myxedema following controlled roentgen-ray treatment is more than balanced by the possibility of recurrent laryngeal nerve injury, particularly bilateral abductor paralysis, or parathyroid injury, following surgery.

Another objection is the increased difficulty of operation following the use of the roentgen ray. The cases coming to operation in the Massachusetts General Hospital after roentgen-ray treatment have been treated there. They have been as a rule exophthalmic cases; if toxic adenomas, the goiter has been small. In these cases there has been no appreciable increase in difficulty of operation. The gland has not been adherent to the anterior muscles. The only change the author has noted has been a somewhat firm consistency to the gland, and possibly a slight increase in fixation posteriorly. The increased operative difficulty has been no more than that after preliminary ligation.

It should be appreciated that there is no less responsibility in advising roentgen-ray treatment than in advising operation. The ill effects of the roentgen ray are more remote, and require more imagination to grasp. If roentgen-ray treatment is advised at all, it should be with the clear understanding that it will be tried for only a few months; that relief is uncertain; that, if improvement is not sufficient at the end of that time, operation must be undertaken. The patient should know that operation will eventually be advisable more often than not.

Fontaine, Bryce W. Pulmonary fibrosis. *J. Am. M. Assn.*, Apr. 21, 1923, lxxx, 1129.

The author reports a case of fibrosis of the lung in a woman, aged fifty-two, complaining of blood spitting which had continued off and on for fifteen years. Quantity of blood had varied from a teaspoonful to a cupful. In May, 1918, the patient had symptoms suggesting a pleurisy in the right base; but no cough nor expectoration. Physical signs were those of a moderate-sized effusion in the right chest; but needling gave negative results. Three months later, a roentgenogram showed consolidation at the right base. There has been no cough, sputum or recurrence of fever. Roentgen examination four years later showed the heart and aorta normal, the left lung still entirely normal; but in the right lung, an extension of the fibrosis had involved the entire right side with the exception of the extreme tip above the clavicle. There was a compensatory curve of the thoracic spine toward the affected side. The physical signs and *x*-ray evidence were in striking contrast to the excellent appearance and physical condition of the patient. There was absolute evidence, as shown by *x*-rays, of existence of the process for at least four and a half years. The diagnosis made was "diffuse fibrosis, sclerosis or cirrhosis of the lungs developing as a sequel to pleurisy." The author devotes considerable space to a discussion of the differential findings. On account of the failure of medical measures in this case, roentgen ray treatment, according to the new deep therapy, was instituted with absolutely no change in the appearance of the lung after one month. However, there has been no bleeding for six weeks and the patient has suffered no ill effect from the treatment.

Osborne, Sutherland, Scholl, and Rowntree. Roentgenography of urinary tract during excretion of sodium iodid. *J. Am. M. Assn.*, Feb. 10, 1923, lxxx, 368.

The authors describe a method by which it is possible to obtain roentgenograms of the urinary tract during the excretion of sodium iodid following its intravenous or oral administration. The method uniformly gives excellent and accurate shadows of the urinary bladder and renders reliable information relative to its size, shape and location. It has been partially successful in depicting the renal pelves and the ureters in a limited number of cases. In a number of cases it assists in revealing the kidney itself through intensifying the renal shadow. It has been proven a success in revealing the existence of residual urine in the bladder and in furnishing approximate information of the amount, thus eliminating the necessity of catheterization and its attendant dangers of infection. Oral administration of the drug will prove satisfactory for routine use in making roentgenograms of the bladder, while for shadows of the ureters and kidneys intravenous injection of large doses of sodium iodid is desirable.

Tees, Frederick J. Anterior dislocation at the elbow-joint. *Ann. Surg.*, May, 1923, lxxvii, 612.

The author reports one of the rare cases of anterior dislocation at the elbow-joint. Quoting from Krönlein's series of 400 recent traumatic dislocations, 109, or 27.2 per cent, involved the elbow; and yet if in all the cases of anterior dislocation of this joint thus far reported we exclude those associated with fracture of the olecranon—which, by common consent, should not be regarded primarily as dislocations—the total number does not exceed 20. The author then reports the details of the case, and in his comment remarks that after scrutiny of a series of *x*-ray plates of the elbow-joint in children, such as have been published in a recent article of Cohn on the developing elbow, one is prepared, from the apparent lack of security in attachment of the main lower epiphysis of the humerus, to expect frequent epiphyseal separation as a result of injury; but the relative insignificance of the olecranon is equally striking, which, it might be thought, would render anterior dislocations of common occurrence. Yet but 3 of 13 cases of Stimson's series in which the age is stated occurred in children under fourteen years of age. The explanation of this extreme rarity seems to lie in the strength of the ligaments rather than in the contour of the bones. The ligaments, even in children, must be sufficiently strong to resist a dislocating force from above and behind (such as occurs in falls on the flexed elbow), and ehnce, as a result of this form of trauma, there is ordinarily produced not a dislocation but a separated epiphysis or a supracondylar fracture.

Deming, Clyde Leroy. Congenital sarcoma of kidney in a child of twenty-nine days. *J. Am. M. Assn.*, Mar. 31, 1923, lxxx, 903.

The author reports in detail this very interesting case which emphasizes the value of complete cystoscopic examination in children; the fact that urograms are just as essential in the examination of infants as in that of adults; and that local anesthesia may be employed effectively in infants.

Zaaijer, J. H. Cardiospasm in the aged. *Ann. Surg.*, May, 1923, lxxvii, 615.

Cardiospasm is, as a rule, most frequently encountered in youth or middle age. When, however, elderly people begin to show symptoms of interference with deglutition, apparently due to some narrowing of the esophagus, one is more inclined to consider the condition carcinomatous and without making an exhaustive examination allow these patients to starve gradually, appreciating the fact that radical therapy is of very little effect and that a gastrostomy merely prolongs for a short time a life of suffering. This danger is illustrated in 2 cases which the author cites in detail, one at the age of fifty-eight and the other at the age of sixty-five. He shows that one should be careful not to make a diagnosis of carcinoma of the esophagus, however probable it may be, merely on account of the age of the patient, thus allowing him to suffer unnecessarily from the lack of treatment which would make him entirely comfortable. The first case shows how completely recovery can be obtained in a case of cardiospasm from stomach-tube feeding and the ultimate restoration of the esophagus obtained, as demonstrated roentgenologically. This case apparently negatives the argument that cardiospasm follows a primary mega-esophagus. It is the author's custom to consider operative intervention as a last resort.

Stephens, Richmond. Fracture of the spine of the tibia. *J. Am. M. Assn.*, Mar. 31, 1923, lxxx, 905.

The condition is one of rather extreme rarity and it is difficult to find very much literature on the subject. Probably the injury occurs more frequently than the records would indicate, however. This injury is due to a severe traumatism, usually of the twisting variety. Rupture of the crucial ligaments is a frequently associated lesion, and is probably due to pull by these ligaments. Diagnosis is difficult without the roentgen ray. Conservative treatment is usually successful in recent cases, and occasionally in old cases. In old cases particularly with blocking of extension, operation is indicated. Operation through a split-patella incision is the best, and removal of the offending fragments is very easy. The final results are excellent in all cases; for, if the conservative treatment does not give a perfect recovery, operation will accomplish this end.

Nuttall, H. C. Wardleworth. Tuberculosis of the sacroiliac joint. *Lancet*, Apr. 28, 1923, cciv, 839.

After discussing the anatomy, pathology, symptoms and signs the author devotes sections to diagnosis, prognosis and treatment. Under diagnosis he states that in the early stage before abscess formation the most reliable sign is the presence of tenderness on direct pressure over the joint. Patients frequently complain of pain over the joint in sciatic neuritis or other conditions, but as a rule true tenderness is absent. In discussing the pathology, it has been seen that the infection is primarily in the bone, and one would expect that a roentgenogram would show some change in the shadow. This must depend on destructive bone changes, which probably take one or two months to develop. Roentgen examination, therefore, is a valuable confirmatory test, and should be repeated after an interval in a suspected case. The other symptoms and signs are commonly present in other diseases and appear more likely to mislead than to aid in diagnosis. In the later stage after the formation of an abscess, the presence of a fluctuating swelling, together with the tenderness over the joint, and the *x*-ray appearance, renders the diagnosis a simpler matter. The abscess may point, however, at a considerable distance from the joint.

In the differential diagnosis the acute infections (pyogenic or gonorrheal), osteoarthritis and sprain are the most important. The chief distinguishing characters are the acute onset, pyrexia and more rapid course of the infective conditions, the likelihood of other joints being affected, the history, and the *x*-ray appearances. Clinically it is impossible to distinguish between early tuberculosis and sacroiliac sprain or relaxation, but the latter speedily recovers with rest and strapping of the pelvis; the roentgenogram is negative.

Another difficulty in differentiation concerns affections of the neighboring bones and joints such as tuberculosis of the hip or spine, scoliosis, chronic sprain of the back, sarcoma of the ilium or the sacrum; and malformation of the fifth lumbar transverse process may be excluded by careful examination and the roentgenographic appearances. For instance, in hip disease limitation of movement is quite definite in all directions; in sacroiliac disease gentle examination shows that movement at the hip-joint is painless in one or other direction. The same remark applies to the spine. A roentgenogram will show growths of the bones or periostitis of the fifth lumbar transverse process in cases where it impinges on the crest of the ilium. Further differentiation may be required between affections of nerves including true sciatic neuritis and other affections such as growths in the pelvis, ovarian or uterine disease or appendicitis.

Bearse, Carl. Osteomyelitis of the ilium in children. *J. Am. M. Assn.*, Apr. 7, 1923, lxxx, 991.

When osteomyelitis of the ilium occurs in children, it is a particularly serious condition, because the diagnosis at first may be difficult. Since immediate prognosis, prevention of complications and shortening of convalescence depend on early treatment, early diagnosis is essential. This condition should always be borne in mind in a case of painful hip that permits motion. The local symptoms are often referred to the hip-joint, and not to the ilium. The important factor in diagnosis is tenderness over the ilium, without restriction of motion at the hip-joint. The roentgen ray is at first of no help, but later of decided aid. The author cites 4 cases.

Summers, John E. Transposition of viscera (situs viscerum transversus). Report of a case without transposition of the usual abdominal reflex. *Nebraska M. J.*, Apr., 1923, viii, 117.

The author reports another case of transposition of the viscera in which there was no transposition of the usual abdominal reflex. No attempt is made to review the literature, the author citing the exhaustive article of James Rae Arneil which appeared in the *American Journal of Medical Sciences*, 1902, p. 885, as being the most exhaustive article on the subject which he could find. The author rehearses 4 cases which were described to him from the Mayo Clinic and adds a 5th case.

Krida, Arthur. Secondary os calcis. *J. Am. M. Assn.*, Mar. 17, 1923, lxxx, 752.

The author reports what he believes to be the first case in the literature where a secondary os calcis was implicated in a traumatism of the foot. He cites the work of Dwight as offering the most comprehensive information in American literature on the subject of accessory bones of the foot. In the great number of dissections that Dwight made, he apparently found only two examples of a separate bone in this situation. From the clinical standpoint, the separate ossicle described by Pfitzner may be accepted as the typical secondary os calcis. Its occurrence in 2 per cent of his large series of dissections need not lead to the expectation of finding it frequently in routine roentgenograms of the foot, as the smaller and less well-developed specimens might easily escape demonstration. It would seem that a well-developed secondary os calcis, acting like a wedge in a series of complicated movements in the middle of the tarsus, would be peculiarly liable to avulsion or displacement.

Hess, Alfred F., and Weinstock, Mildred. A study of light waves in their relation to rickets. *J. Am. M. Assn.* Mar. 10, 1923, lxxx, 687.

The authors undertook a series of experiments which seem to indicate that in order to be of value in rickets, ultraviolet waves must have a wave-length not longer than 302 or possibly 313 millimicrons. This renders light that has passed through ordinary window glass of no therapeutic value in this disorder. The shortest waves of sunlight that reach the surface of the earth are about 290 millimicrons, and vary greatly in intensity according to the time of the day and the season of the year. Indeed, when the atmosphere is heavy with moisture, smoke or dust, the shortest of these waves are absorbed. It is evident, therefore, that the range of effective radiations is markedly circumscribed by nature, and further limited by meteorologic conditions. The foregoing experiments serve to emphasize the remarkable specificity of wave-lengths of light in relation to rickets. It can be stated with confidence that waves 324 millimicrons in length have little or no value in protecting against rickets, and that waves of 302 millimicrons are of great value in this respect. This signifies that a difference of about thirty millionths of a millimeter in wave-length suffices to render ultraviolet light effective or ineffective. The experiments with clothing material indicate that the rays do not have to impinge directly on the surface of the skin. Clothing must be regarded as other filters which screen the effective rays, namely, according to their texture or thickness. Furthermore, a direct quantitative relationship exists between the nature of the material and the duration of exposure to sun's rays or artificial sources of light. Black clothing will absorb more of the effective ultraviolet rays than similar white material.

The spectrum would seem to contain not only rays which can prevent or cure rickets, but also longer rays which are able to neutralize or inhibit the effect of these beneficent radiations. This phenomenon points to the need and the value of an analysis of rays employed in heliotherapy in rickets, tuberculosis, and other diseases. It would seem to indicate that this valuable therapeutic agent will be used with the employment of filters to absorb radiations which may be not only ineffective but counteracting.

Japiot. Contribution to the radiographic study of the causes of lumbar arthritis. *Lyon méd.*, 1921, cxxx, 1090.

Lumbar arthritis, the lumbar localization of ossifying spondylosis, with lateral exostoses in the shape of beaks and hooks, is at present considered very unusual. Japiot has himself found 20 cases of it.

It is generally admitted that the cause is rheumatic; but it seems to him, from his observations, that it frequently has a different origin.

1. It can be traumatic. The author published in the same magazine a report of a very characteristic case resulting from a vertebral compaction. Since then he has seen 2 more cases. Finally, Professor E. Martin has collected a remarkable specimen from a man long ago traumatized; the characteristic exostoses exist in a ladder formation along a large portion of the spine, and clinical observation leaves no doubt as to the relation between these deformations and the accident.

2. It can be tuberculous. In support of this opinion Japiot presents:

Two specimens from De Gallois' collection permitting a comparison between rheumatic spondylosis and that connected with Pott's disease.

A series of photographs sometimes only allowing tuberculosis to be suspected (compaction and disappearance of a vertebral body) and confirming it twice (abscess by congestion).

How can the real cause of lumbar arthritis be recognized? Evidently clinically more than otherwise. It seems to him, in addition, that the close localization of the process upon the body favors a non-rheumatic cause.

One can easily see the importance of these facts from a diagnostic point of view in judging industrial accidents (traumatic spondylosis), and from the therapeutic point of view (immobilization of tuberculous spondyloses).

Kelly, Howard A. Radium therapy, with special reference to diseases of the female pelvis: A rejoinder. *Therap. Gaz.*, Nov. 15, 1922, xlvi, 761.

Dr. John B. Deaver, in the *Therapeutic Gazette* of July 15, 1922, published an article which was conspicuously anti-radium. This article by Dr. Kelly is a rejoinder. He does not hesitate to state that Deaver writes on a subject about which he appears to know little and that little evidently from hearsay. Deaver's article, however, serves to exhibit the confusion of the average general professional mind on this "comparatively new, very special, most promising, and tremendously aggressive form of therapy."

At the very outset Kelly submits that: "It is unfair and destructive to the eager expectation of our sorely afflicted humanity, ever straining its eyes toward the horizon in hopes of relief from some of the diseases with which it is afflicted, to write such a deprecatory article on so valuable, well-known and already well-tried an agent as radium. It is likewise an unpardonable omission not to mention with a heart overflowing with thankfulness the unparalleled blessings which have already come to so many thousand sufferers through this agent in a great variety of fields. I refer here to the lympho- and angiosarcomas of the nasopharynx and of the whole body, to Hodgkin's disease, to the leukemias, to mediastinal tumors, to many brain tumors, to the primary testicular carcinomas, to the sarcomas of the ovary in children, and many other ailments. There ought to be at least a glimmering sense of gratitude that radiation can bring about painless and bloodless cures in ailments in which true surgery has never even dreamed of making an effort—and that, too, radium cures are lasting already for years.

"Were it not for personal attachment and for the high esteem in which we all hold Deaver as one of our keenest cutters and most doughty wielders of the scalpel, I would dismiss his strictures upon radium with the citation of an old college skit on Bishop Berkeley, the idealist, which ran, 'When Bishop Berkeley said there was no matter, it was no matter what Bishop Berkeley said.' But inasmuch as I profess to be a cosmothetic idealist, I will try to undo some of the harm Deaver's misleading and injudicious article may have wrought.

"Let us pass in silence his reference to the 'biologic effect of radium' and the 'law of Bergonié and Tribondeau,' to which he adverts after the gingerly fashion of one who craves credit for erudition, but who is conscious of treading boggy ground."

"We all heartily concur with Deaver in urging a continuance of the campaign to bring patients to treatment in the early stages of cancer, and, where possible, to remove the causes of irritation, the forerunners of certain cancers. It should be remembered, however, in the fight against cancer, that our means of knowing the early stages are limited except in a few well-defined localities. Even if a diagnosis could be made, how many cancers of the brain, cancers of the lung, cancers of the pancreas and so forth could be cured by operation? One might say, therefore, that the broad statement that in the early stage cancer is local, amenable to treatment, and almost certain of cure, is somewhat of a surgical illusion."

Kelly confines his discussion to the four gynecological conditions mentioned by Deaver in the article above referred to, namely: (1) Fibroid tumor of the uterus. 2. Hemorrhagic uterus. 3. Cancer of the body of the uterus. 4. Cancer of the cervix.

In regard to *fibroid tumors of the uterus*, Kelly pronounces this dictum: "He who would give his patient the same consideration he would give to his wife or his sister, must put radium first in the treatment of fibroid tumors." The fibroids calling for treatment are those which are growing, those which are bleeding, those which disturb function or cause pain by pressure on neighboring organs, and those whose nature is in doubt. In the last group we include those in which a clear diagnosis is not possible. If there is anything suspicious about the tumor, in the rapidity of its growth and its softness, or any suspicion of an ovarian tumor complicating it, or lateral inflammatory disease, then operation is the choice. Every patient with a uterine fibroid with bleeding or discharge should be subjected to a preliminary dilation and curettement as a routine procedure. In the uncomplicated fibroids, especially when associated with excessive bleeding, there is no treatment as satisfactory as radium. Kelly asserts that even in the large tumors a large percentage show either complete disappearance or a marked reduction in size. Of course, calcified, cystic fibroids and occasionally other forms do not respond by decrease in size.

In younger women, Kelly advocates myomectomy, although he has been able in a number of cases to shrink fibroids by irradiation without disturbing the patient's menstrual function for more than a few months or at the most for a year or two. Radiated fibroids often disappear completely, but even if the fibroid only shrinks and causes no more trouble the result is satisfactory, inasmuch as some 20 per cent of all women have just such small fibroids, and many never even know it. "It is blessed foolishness to declare that a mutilating surgical operation, which removes the womb just for the sake of getting out some fibroid tumors encapsulated in it, is a satisfactory operation, while to stop the growth of the tumor and shrink it with radium is unsatisfactory."

The hemorrhagic uterus. This condition was often mistaken for cancer of the uterus and the removal of one of these uteri was often a source of humiliation to the surgeon. Radium, however, comes to our aid by the simple expedient of inserting a tube of radium into such a bleeding uterus, say 100 mgm. or its equivalent, for fifteen hours—presto! the hemorrhages disappear and the patient is cured. This is so far the greatest triumph in surgery since this century began. If radium did nothing else but bring relief to this one group and eliminate surgery, it would be worth all the investments of all the clinics in the country.

Fundus cancer. Kelly believes that here surgery is the method of choice; but he is thankful, in the cases where surgery is not applicable, to be able to use radium with so much success and the hope of a prolonged and remarkable improvement.

Kelly's remarks concerning cure are worth considering. He says: "Let us sometimes with the patient's peace of mind in view, use the word 'cure' in a modified sense. 'Palliation' is relief, more or less complete, of distressing symptoms, while the disease obviously remains, to advance at a later date. When shall we use the word 'cure' in reference to an apparently effective cancer operation or treatment? If we demand certainty, then we can never say a patient is cured, for the five or even ten year limit is purely arbitrary and not decisive. Why not then say 'cure' when after the first year there are no discoverable signs of disease, being aware that there will be a certain percentage of relapses? I urge this in the interest of the patient, who can then for a time forget the sword of Damocles. I commonly say to the patient, 'As far as I can see you are perfectly well, and I am expecting you to remain well; now go about your business, but report to me every five or six months, for several years.' Let us not be so ultrascientific as to forget the patient's point of view."

Cancer of the Cervix. We again quote the author. "This is manifestly Deaver's crux, and here he falls into as distressing error in comparing operative with radium cures. Let me ventilate his confused logic and false conclusions by transferring the comparison to another field. Suppose I had declared some years ago that I now had a new and successful method of treating all breast cancers, of whatever nature and however advanced, and that I received and treated all cases indiscriminately as they came to me, and I was then able to report a 20-per-cent five-to-seven-year cure. Then along comes a zealous disciple of the knife, who has operated only upon selected cases which showed no axillary involvement or distribution beyond the freely movable breast, rushing into the arena, crying, 'Hey, I have far better results, I have saved 25 per cent by operation. Away with your new remedy!' Where, I ask, is the sense of comparing such utterly dissimilar groups except to declare at once, 'How far superior is the method which deals so successfully even with the advanced hitherto hopeless cases?'"

Here Kelly quotes from a letter written him by John G. Clark July 18, 1922, as follows: "Of the large number of cases which we have treated for the last year or two practically none were operable, and because of the astounding good result in some of the apparently hopeless instances, we have very materially decreased the number of our operations in cancer of the cervix. Indeed, we scarcely operate any more in the latter cases. I have always tried to emphasize as strongly as possible the fact that if we can get a 20 per cent three-year salvage in the hopeless cases we ought to do better than 33 per cent in the operable cases of very limited growths, hitherto submitted to a very extensive panhysterectomy."

The author then goes on to divide cancer of the cervix into three classes:

1. With extensive lateral involvement and fixation.
2. Where the lateral infiltration is moderate and where neither side is fixed.
3. Where the disease appears limited to the cervix and mobility is not interfered with.

A rectal examination is imperative and decisive as to extent in nearly all cases. In the first group operation is worse than futile; radium often, however, gives great relief in checking hemorrhages and discharges and relieving pain. Occasionally one gets a cure here if enough radium is judiciously used. Group 2, with evident lateral involvement, is a group where the surgeon's hands ought to be tied. Here again radium palliates without the risk of operation. In Group 3 it is quite certain that radium gives a high percentage of permanent cures, almost certainly higher than operation alone, and without its attendant mortality and morbidity. In those early cases in which the general condition of the patient is good, a combination of operation and radium is for the present highly to be recommended, that we may know whether the combination gives us the best frontal attack on our dread enemy. Such a combined treatment may well be better than either radium or surgery alone. It also makes possible the implantation of radium points into any discovered glandular metastases. Where pre-operative radiation is given, the operation should be done in the first three or four days after radiation. A longer period of delay leads to sclerosis of the parts and makes the operation much more difficult.

Kelly concludes: "I havé no quarrel with the man who goes on operating for the present on these properly selected cases of cancer of the cervix, for we who are engaged in a new work, exploiting fresh fields, have no right to expect the entire profession, busy about so many things, to catch our vision at once. But I do have a gravamen of complaint against any one who would hinder our work, rob our patients of their hope, and some of their lives, and, by disseminating doubts, and by innuendo, obstruct our path. I also inveigh against him who operates on Groups 1 and 2, which are so obviously unfit.

"When my friend declares that radium is a failure in the face of these overwhelming experiences, I reply in the words of Priscilla of old, 'Speak for yourself, John!'"

Reichold, Albert. The effect of roentgen rays on the mitotic cells in carcinomatous tissues and on the blood-vessels. *München. med. Wchnschr.*, July 15, 1921, lxviii, 881.

Important results were expected some time ago from the roentgenization of malignant growths, but these expectations have not been realized. Despite improvements of the technique and the variety of the radioactive substances a great majority of the tumors do not react to roentgenization. The author has examined the effect of roentgen rays of the mitotic cells obtained from carcinomas. Five cases of cancroid of the lip were thus examined, which were radiated after intervals of a few days with between 10X and 20X through an aluminum filter 3 mm. thick. After each roentgenization small portions of tissue were excised for examination. It is very important that these specimens should be placed in 10 per cent solution of formalin, as changes may otherwise occur in the extirpated tissues. The specimens were stained with sulphate of iron and ammonia and with hematoxylin. The carcinomas disappeared as a result of the roentgenization. The histologic examinations showed in all these 5 cases, rich mitotic cell formations, which the author believes to have caused the disappearance of the carcinomas after roentgenization. In sections the size of 1 sq. mm., from 10 to 15 mitotic cells were found. Soon after the second and third roentgenization a noticeable karyokinesis could be observed, and the diaster forms had disappeared totally. In specimens which had been irradiated with 100X, all tumor cells were found, after four days, to show symptoms of degeneration. The changes in the blood-vessels in these irradiated preparations were also very interesting. After irradiation with a dose of 100X, the vascular tissues had the aspect of cavernous tissues. The intima cells changed their forms and became cubic. In later preparations manifold compact cell-syncytia from intima cells were found.

On the basis of these observations the author believes that the mitotic cells are the parts of the carcinoma most sensitive to roentgen rays, and that an enormous increase of the vessels occurs after roentgenization, this apparently taking an active part in the cure of the carcinoma.

Parrisius, W. Warning against overdosing with *x*-rays in cases of myelomatous leukemia. *Strahlentherapie*, Feb. 15, 1921, xii, 234.

The undoubtedly good results obtained from roentgenotherapy carefully administered in leukemia may easily be counteracted by too long continuance or by too severe a dosage. Four cases are cited in which ill effects were attributed to these causes. In all, the threatening condition improved, but following the treatment there were: rapid loss of strength, attacks of cardiac insufficiency, rapid destruction of leukocytes, and shrinking of the spleen. Such disasters are obviated completely by the author's technique. He treats the patient eight times in twelve weeks, using a 6 by 8 cm. field, 23 cm. focal distance, a ½ mm. zinc filter, plus a 1 cm. of aluminum, the duration being six minutes. The last sittings may be lengthened to eight and ten minutes. This represents one-sixth, later one-quarter to one-third of the erythema dose. Every second day a blood examination is made, to determine whether the leukocyte count has fallen and the patient therefore has become ready for another treatment.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X AUGUST, 1923 No. 8

ROENTGEN-RAY STUDY OF NON-LUETIC PERIOSTEAL BONE LESIONS

BY ROY G. GILES, M.D.

X-Ray Department, Massachusetts General Hospital

BOSTON, MASSACHUSETTS

THE periosteum is a tough fibrous membrane adherent to the surface of the bone except at its extremities, where it is covered with cartilage. Normally the periosteum does not cast a shadow on the roentgenogram. It becomes apparent only when calcium salts have been deposited in it.

Periosteal bone production is not a clinical entity within itself, but a manifestation of the reaction of the periosteum to some irritant acting as a stimulus to bone production. The new bone is laid down in the same manner in the majority of the cases, without regard to the stimulus causing the deposition of lime salts in the periosteum, and for this reason it may often be impossible to differentiate the various conditions bringing about a periosteal reaction.

Roentgen-ray evidence of non-luetic periostitis and the formation of new subperiosteal bone is seen in a great number of bone affections. Among these may be mentioned: fractures; trauma without fractures; osteomyelitis; tuberculosis; typhoid; leprosy; pulmonary osteoarthropathy; osteitis deformans; rickets; scurvy; and the proliferative type of bone tumors.

Proliferative Lesions Due to Fractures. In fractures the fragments may be displaced and the periosteum stripped up or torn away from the shaft. The periosteum as a result of this trauma may receive a gradual deposit of mineral salts and cast a shadow on the roentgenogram in from one to four weeks, depending on the age and the condition of the patient. Such a condition is by no means common, but may occasionally be seen extending over a considerable portion of the bone.

Callus is formed in the same manner, and in addition includes the new bone thrown out around the ends of the fragments.

It seems reasonable that a trauma may initiate an irritant stimulus, causing the deposition of lime salts in the periosteum, resulting in a true traumatic periostitis. Much stress is laid on the occurrence of traumatic periostitis in the earlier literature. But MacCallum,[1] in his text-book on pathology, does not mention such a condition. Bloodgood[2] states: "I have been surprised at the infrequency of periosteal bone formation after trauma. In a large number of cases I have made x-ray studies after trauma and at intervals until all symptoms had disappeared with negative findings." Albee[3] describes simple inflammatory periostitis, which he states is usually traumatic in origin: "In acute cases of this lesion the x-ray shows no changes in the outline of the affected bone, even though considerable swelling is present clinically. In subacute and chronic cases, a faint shadow appears along the shaft, due to the deposit of lime salts in the thickened periosteum."

Local injury may permit the access and favor the production of pyogenic microorganisms, by producing tissue damage. Such a condition may give rise to an osteomyelitic process. But after reviewing a large number of radiograms, and the histories of patients showing *x*-ray evidence of periostitis, even though the onset of the illness in many cases dated from a trauma, we are unable to find a case of traumatic periostitis, without evidence of secondary infection.

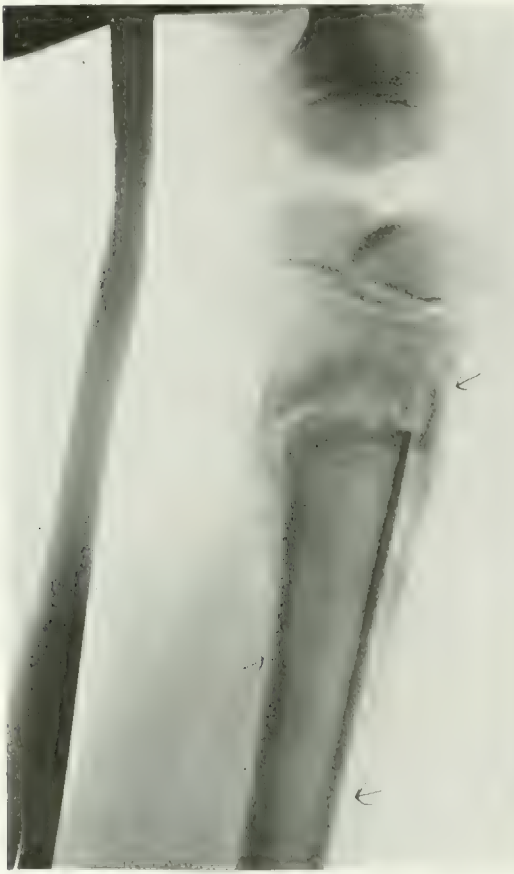


Fig. 1. Fractures of the lower end of the femur of six to eight weeks' standing, showing rather extensive periosteal changes; line of fracture is visible, and alignment is good.

Periosteal Changes Due to Osteomyelitis. Osteomyelitis may occur spontaneously, and it is often accompanied by a periostitis, due in the majority of cases to staphylococcus aureus and albus. The streptococcus may also give rise to osteomyelitis. Trauma is a common predisposing cause. Injury may produce an area of lowered resistance and favor the entrance of microorganisms directly by means of a wound through the blood stream, or from a focus of suppuration in the skin, the subcutaneous or the deeper tissues. Perhaps at least one half of the cases will give a history of injury. This type is most often seen in the young. Growing tissue is more easily affected by microorganisms than is mature tissue, and osteomyelitis usually begins in the region of the epiphyseal line, where new bone is being formed. Similiar conditions may occasionally be met with as complications of certain diseases such as variola, measles, whooping-cough, pneumonia, influenza, typhoid relapsing fever, scarlatina, etc.

Osteomyelitis may involve any bone, but the most frequent sites are the femur and the tibia. The disease usually begins in the medullary canal or beneath the periosteum. When the infectious process is carried through the blood stream, it generally begins in the medullary canal. When the infection is set up as the result of a trauma, the disease usually starts in the cortex of the bone. During the very early stages of the disease, the infectious process may be confined to the medullary and

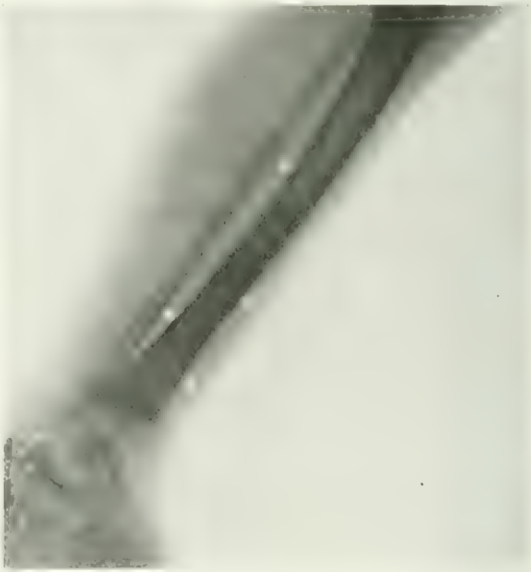


Fig. 2. Osteomyelitis following whooping-cough and pneumonia. The periosteum is raised and shows evidence of proliferation on either side of the bone, with little evidence of bone destruction.

Haversian canals without causing any variation from the normal in the radiographic appearance of the affected bone. After ten to fourteen days, areas of rarefaction are seen on the *x*-ray plate and may be accompanied by more or less extensive periosteal proliferation, depending upon the extent of the diseased process, since the periosteal reaction is the direct result of the irritation beneath it. The areas of destruction coming in contact with the living bone cause the normal bone to become inflamed and ulcerated about the margins of the dead bone, helping in the formation of sequestra.

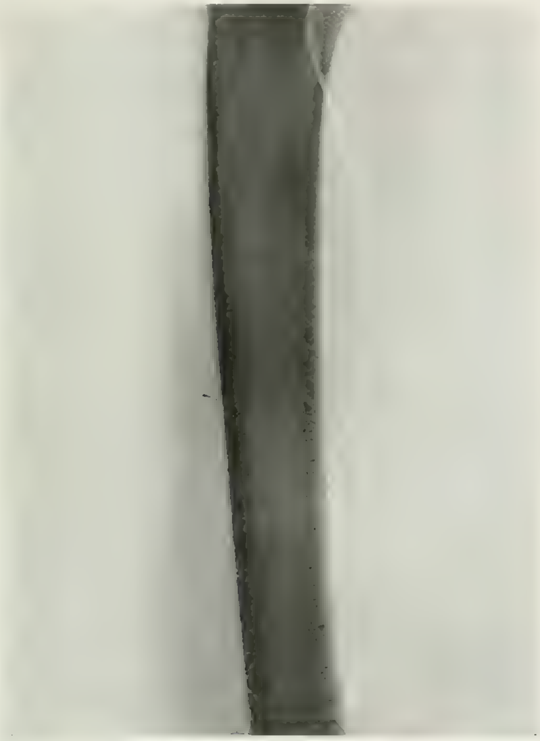


FIG. 3. Pathological Report: Staphylococcus aureus. Acute case of osteomyelitis of three to four weeks' duration. Note periostitis in lower third of femur.

When the infectious process starts beneath the periosteum, the infection spreads more easily into the periosteum, and the cortex becomes involved more slowly, due to its density. This type is characterized by marked periosteal proliferation, accompanied by very small areas of destruction.

In chronic osteomyelitis the *x*-ray shows a pathological process confined to the shaft, which may include a large part of the bone involved. The original bone is often thickened and irregular, due to the deposit of successive layers of periosteal bone on the cortex, often causing the medullary canal to appear narrowed. The cortical bone may show small areas of destruction, as illustrated by irregular patches of decreased density due to the small areas of infection remaining.

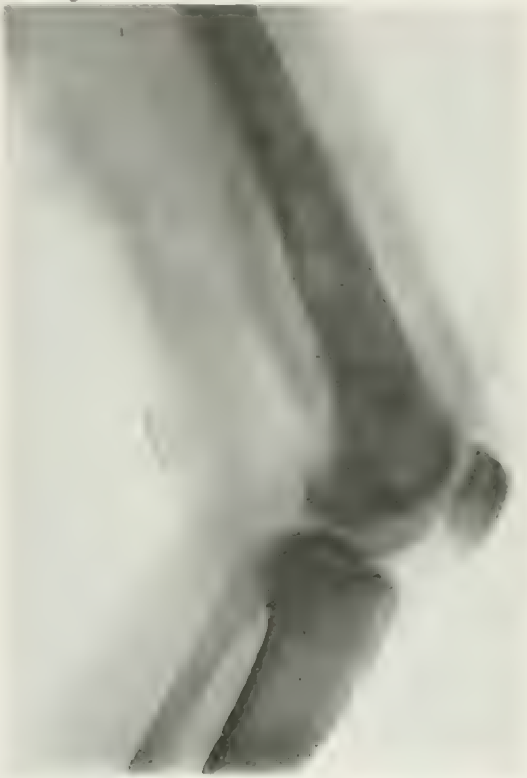


FIG. 4. Chronic osteomyelitis. Extensive periosteal involvement of the lower end of the femur, nearly to the middle of the shaft.

Periosteal Changes Observed in Tuberculosis. In this country tuberculosis of the shaft of the long bones has been considered a very rare condition. Radiographically the condition appears as irregular, slight or extensive areas of destruction in the cancellous bone or the medullary canal. The periosteum is involved only as the result of secondary infection. For this reason, tuberculous lesions producing periosteal reactions are generally indistinguishable from osteomyelitis of pyogenic origin.

In children the short bones of the hands and feet are prone to tuberculosis. The condition appears on the roentgenogram as irregular punched-out areas in the medulla and cortex. The diseased phalanx is increased in size and may be accompanied by a periostitis. Frequently the enlarged phalanx is accompanied by a rearrangement of the bone structure. Syphilitic dactylitis seldom shows areas of destruction. The increased size of the phalanx is the result of the elevation and thickening of the periosteum.

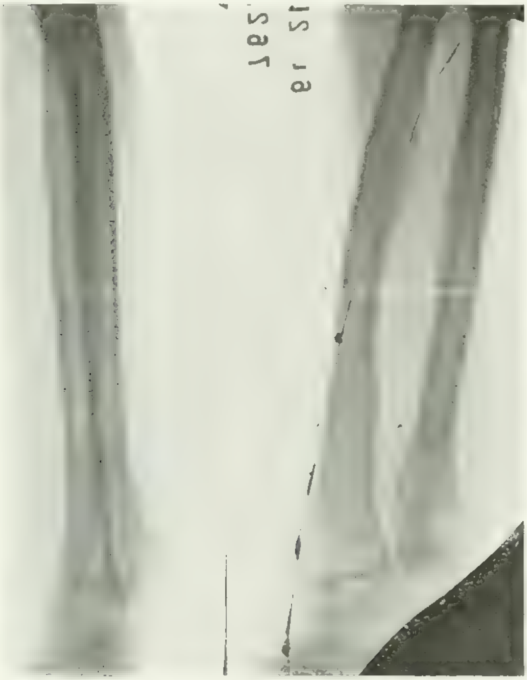


FIG. 5. Pathological Diagnosis: Tuberculosis ulna. There is a line of absorption just above the epiphyseal region; the other changes are almost entirely periosteal. The soft tissues in this region are very much thickened.

Periosteal Changes Due to Typhoid. This is a rare condition in the bone and most frequently attacks the spine and ribs, less often the long bones. The vertebrae are blurred and indistinct when the spine is involved, but the intervertebral discs are not destroyed, as in Pott's disease.

Typhoid of the long bones appears on the *x*-ray plate as a circumscribed area of rarefaction in the cortex, accompanied by a thickening of the cancellous bone in the immediate vicinity of the diseased part. Occasionally there may be a local or extensive periostitis accompanying the area of destruction in the cortex. But there are no special characteristics by which it can be distinguished by means of the *x*-rays from the usual types of inflammation.

Periosteal Changes in Leprosy. In leprosy the bones of the hands and feet show the most marked changes. The lesions are characterized by a variable degree of atrophy and are generally accompanied by a periostitis. Honeij[4] summarizes the bone lesions as follows: "In general the bone changes observed vary from thinning, atrophy, or periostitis, to advanced changes with total absorption of phalanges, marked inflammatory action in the bone, distortion, ankylosis and fractures. Changes may begin in the corticalis, or medullary canal, and apparently any or all of these changes may occur in the same set of bones." The periosteal changes in leprosy alone may be difficult to distinguish on the roentgenogram from syphilis, but the characteristic changes that go with it, together with the history and clinical

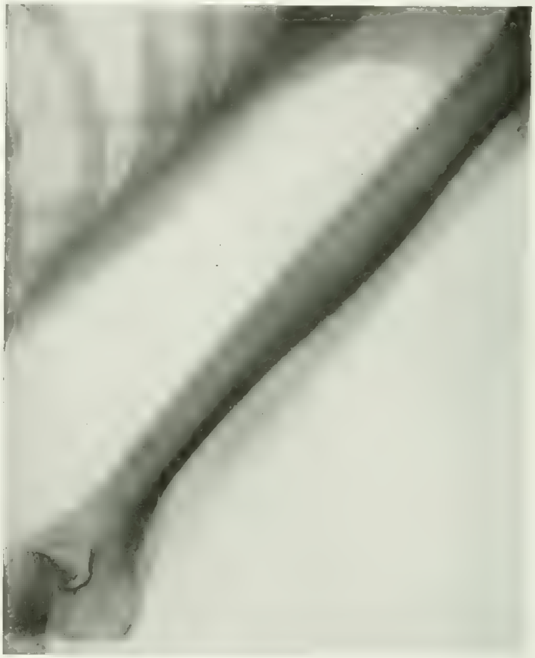


FIG. 6. Hypertrophic pulmonary osteoarthropathy. Marked increase in periosteum which has a peculiar moss-like appearance, and the process is limited to the periosteum.

course, render a mistaken diagnosis highly improbable.

Periosteal Changes in Pulmonary Osteoarthropathy. It is generally conceded that this rare condition follows the absorption of toxins from a septic focus, most often primary in the lungs. It has been found to accompany bronchiectasis, empyema, lung abscess, pulmonary tuberculosis with abscess formation, malignant neoplasms, and congenital heart disease. Locke[5] considers clubbing of the fingers an early symptom, but there are cases reported in which it is absent. The hands and the feet as a rule show marked enlargement, accompanied by tremendous bone production in the periosteum, as shown on the roentgenogram. There may be seen a clear space between the bone and the periosteum giving it the appearance of being stripped up. The early process is seen first in the distal ends of the distal bones. Later these bones usually show the most marked changes. No bone is exempt except those of the head and face. The bone itself shows no changes.

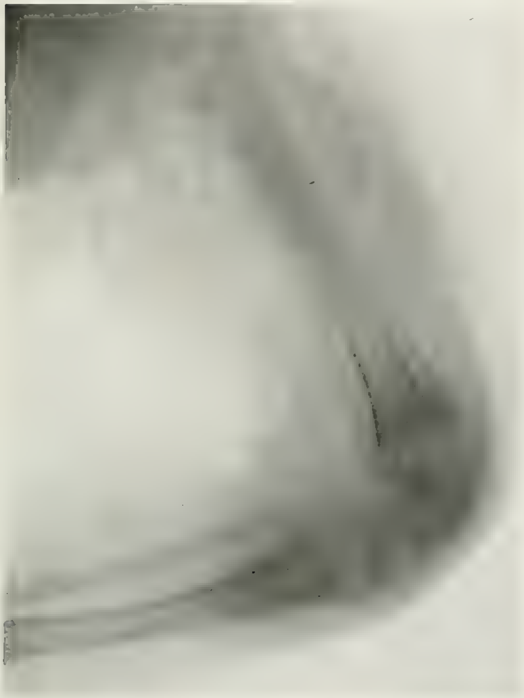


FIG. 7. Scurvy, well advanced. Note separation of periosteum and displacement of the epiphysis due to hemorrhage.

Periosteal Changes in Osteitis Deformans. The etiology of osteitis deformans seems as obscure as when Sir James Paget[6] first described the disease in 1876. He regarded the condition as the result of chronic infection. It is most commonly seen after the age of forty, though cases are recorded in the literature as early as eight and as late as seventy-nine years of age. The condition does not tend directly to shorten life, and there is no racial predisposition or immunity to the disease. The bones and soft tissues of the hands and feet may be enlarged; the skull when involved is the most characteristic. As a rule, the disease involves more than one bone, but may be limited to a single bone, most commonly the tibia.

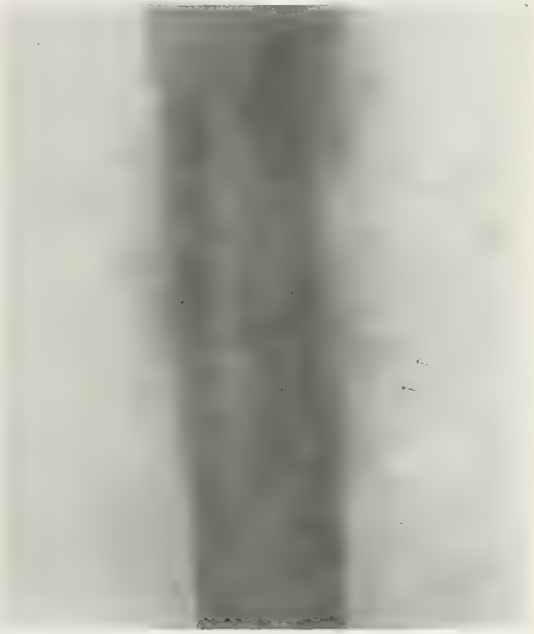


FIG. 8. Periosteal sarcoma. Note the characteristic radiating line.

The roentgenogram shows thickening of the cortex on both sides, usually more pronounced on one side than the other. Lime salts are deposited beneath the periosteum, and the new periosteal bone is laid down parallel with the cortex. As a result there is marked overgrowth of the bony structures and abnormal trabeculation.

Perhaps osteitis deformans is most often mistaken for certain types of syphilis.

In osteitis deformans there is frequently marked bowing of the tibia, due to actual enlargement of the bone. There may be pathological fractures, which are, as a rule, accompanied by very little callous formation, whereas in syphilis, fractures are seldom seen, and then only as the result of very severe violence. In syphilis the epiphysis is seldom involved, whereas in osteitis deformans it usually takes part in the general process.

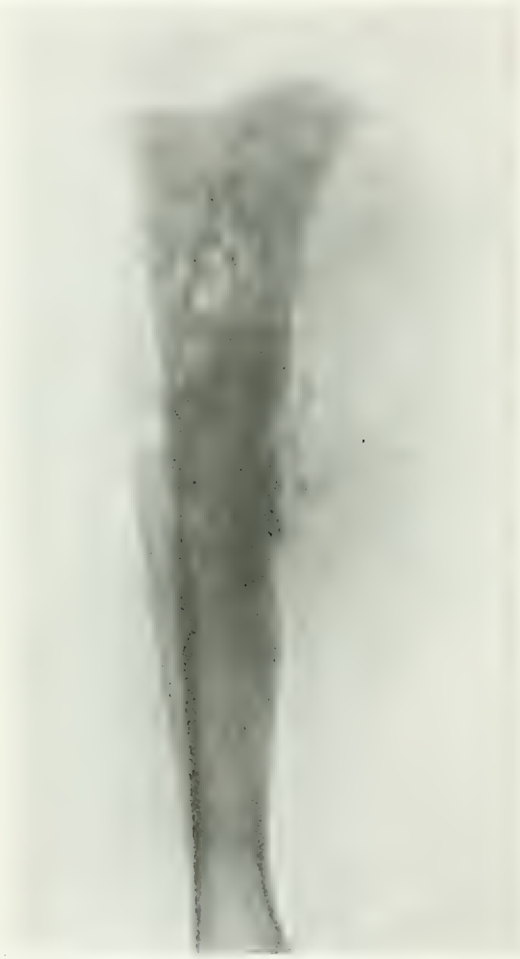


FIG. 9. Pathological Report: Periosteal sarcoma. Note the periosteal bone proliferation extending into the soft tissues on either side of the shaft and erosion. There are no lines running perpendicular to the shaft.

Periosteal Changes in Rickets. Rickets is a chronic acquired disease occurring most often during the first two years of life. All the tissues in the body may be affected, but the principal pathological changes are seen in the long bones. The most important changes are in the epiphyseal line and neighboring joint. The diaphyseal end of the shaft flares outward and its edges become irregular and jagged. A moderate degree of periostitis sometimes occurs in rickets. The shafts of the long bones, more especially the lower extremities, are frequently bent, showing a thickening of the cortex on the concave side of the curve. Thickening of the cortex on the convex side of the curve, accompanied by a periostitis, is usually due to syphilis.

Periosteal Changes Due to Scurvy. Scurvy, like rickets, is usually seen during the first years of life. The radiogram shows no changes in the epiphyses or the epiphyseal line. The earliest evidence of the disease is the appearance of a white line two to three millimeters behind the epiphyseal line and parallel to it. The white line frequently looks like a second epiphyseal line on the roentgenogram. In scurvy, periostitis is frequently accompanied by hemorrhages beneath the periosteum. At first the subperiosteal hemorrhages may be unequally distributed, so that the periosteal elevation may appear irregular and uneven, over the entire length of the shaft of the bone. The subperiosteal hemorrhages soon undergo organization and mineral salts are deposited in the periosteum as well as in the blood clot.

Periosteal Changes in Bone Tumors. Periosteal neoplasms usually lay down new bone perpendicular to the shaft. Since all the periosteal neoplasms produce new bone in much the same manner, the *x*-ray cannot differentiate the various types, but in the vast majority of cases the benign can be separated from the malignant on the roentgenogram as well as in the gross specimen.

These tumors are most common in young people and seem to have a peculiar affinity for the bones around the knee. These are bone-producing tumors, and the malignant type often grow very rapidly. In the malignant type the new bone appears on the roentgenogram as fine calcified striae, radiating at right angles to the cortex and terminating freely in the soft tissues. The shaft and the periosteum may show a more or less marked degree of destruction. But the majority of the changes are outside the bone proper. These radiating spicules, when present, make this tumor probably the most characteristic of all the bone tumors, and they have been called "spikes" by some writers. Baetjer[7] refers to these characteristic radiating spicules as "resembling the rays of the sunset."

Occasionally syphilis may lay down new periosteal bone perpendicular to the cortex, but in this case the fine striae of mineral deposits arch together at their terminations, instead of terminating freely in the soft tissues.

I wish to thank Dr. George W. Holmes for his assistance in the preparation of this paper.

BIBLIOGRAPHY

1. MacCallum, W. G. Text-Book of Pathology. Philadelphia, 1919, p. 848.
2. Bloodgood, J. C. *J. Radiol.*, March, 1920.
3. Albee, F. H. Text-Book of Surgery. Philadelphia, 1919.
4. Honeij, J. A. Am. J. Roentgenol., Oct., 1917, iv, 494.
5. Locke. *Arch. Int. Med.*, 1915, xv, 659.
6. Paget. *Med. & Surg. Trans.*, 1876.
7. Baetjer and Waters. Injuries and Diseases of the Bones and Joints. Paul B. Hoeber, Inc., New York, 1921.

THE INTESTINAL RATE AND THE FORM OF THE FECES*

BY FRANCIS LOWELL BURNETT, M.D.

BOSTON, MASSACHUSETTS

A MEASURE of time on the circulatory and respiratory systems has been established for many years and found useful. The pulse beat and the respiratory rate are of value not only in the determination, but also in the consideration of the outcome, of morbid processes. The intestinal rate, however, has received scant consideration; but as the tissues of the body are dependent on the amount and kind of assimilation, which is due to the proper chemical reduction, which in turn is nicely adapted to the rate of passage through the different parts of the tube,[1] an understanding of the variations of the intestinal rate and the form of the feces is likely to prove valuable in the most essential process—proper nourishment—and the maintenance of a harmonious body.

The study previously given to the time taken by substances to pass through the alimentary tract has been in attempts to define the normal rate; but the results have been so at variance that they are without practical value. Thus Hurst,[2] by means of barium and the x-ray, says the rate depends on the time of ingestion and defecation, and gives figures from nine to thirty-three hours. Then Case[3] believes that the colon should be empty by the end of thirty-six hours; but Barclay[4] says that there are plenty of women in whom the opaque meal takes forty-eight hours or longer to reach the rectum. And Straus,[5] by the use of carmine, gives twelve hours as the minimum and forty-eight as the maximum for normal limits. Finally, I have suggested that the normal time is about sixty-four hours.[6] Such variations are readily explained in a large series of determinations; especially when it is found possible to change the rate in a subject by dietary treatment.

In this investigation of the intestinal rate the estimates were made by the study of 40 plates in x-ray exposures taken five, ten, twenty-five and fifty hours after the ingestion of a barium meal; but more often by seeds given 60 subjects in 250 tests and observed in about 1,000 stool examinations. The tests counted were only those of subjects having one or more natural dejections daily. An illustration of the x-ray method is shown in Figure 1. This picture represents two series of exposures; in the upper, showing a rapid intestinal rate, only a little barium remains in the gut after twenty-five hours. Such a condition is associated with soft and formless feces, as shown in Figure 3. In the lower, most of the barium is apparent in fifty hours, and in the sigmoid it is formed into discrete masses. This condition is associated with feces entirely formed in units as shown in Figure 5. The upper series was taken of a patient with psoriasis, whereas the lower was of an unusually healthy individual.

---

* From the Skin Clinic of the Massachusetts General Hospital.

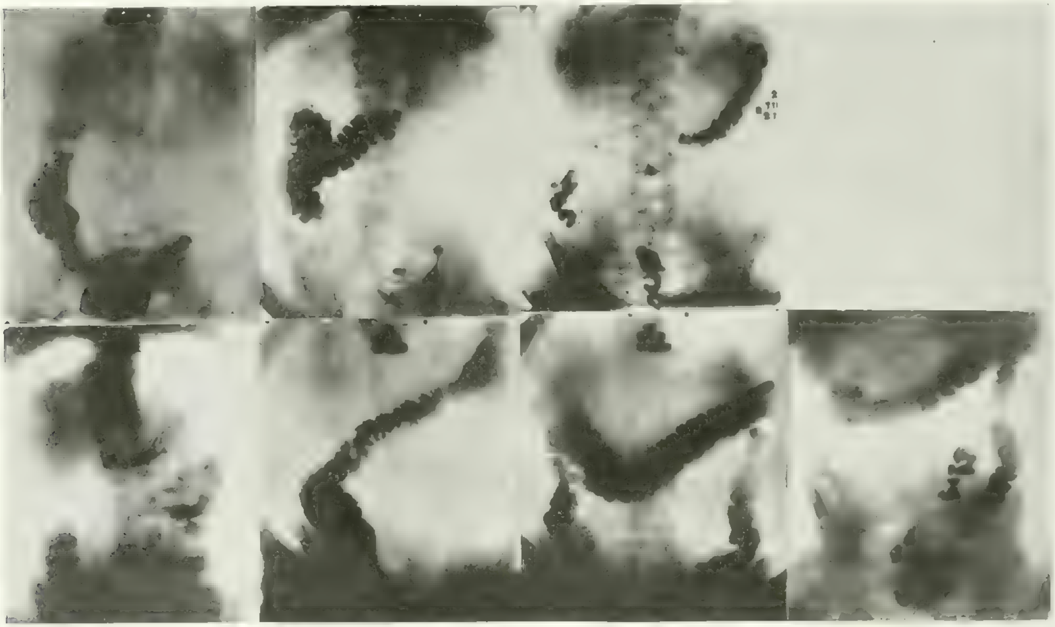


FIG. 1. Roentgenograms of two subjects taken five, ten and twenty-five hours, and one fifty hours, after the ingestion of a barium meal.

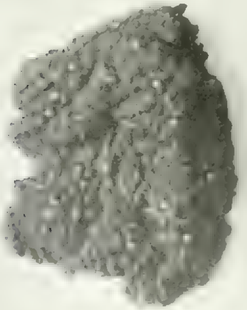


FIG. 2. Semisolid feces (diarrhea).

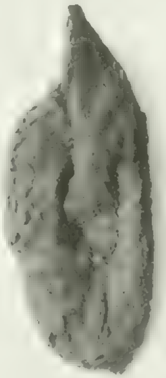


FIG. 3. The soft and formless type.

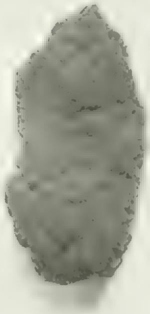


FIG. 4. A stool formed with marks.

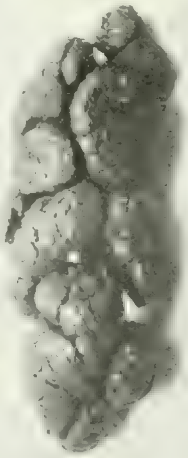


FIG. 5. Feces entirely composed of units.

While the *x*-ray method is applicable in a large hospital, it is too intricate and expensive for general use; accordingly another means was devised, which though simpler, is sufficiently accurate to give very striking results. By this method a measure of 50 c.c. of French millet seed was given a subject immediately after an evening meal. Then the subsequent dejections were examined, and the time noted when more than five seeds were first and last seen. In this way the number of hours elapsing from the time of ingestion to the appearance of the seeds represents the initial rate; while from the time of ingestion to the hour when the seeds were last seen is the measure of the final rate. That is to say, if seeds taken on Monday at 6 p.m. were first seen on Tuesday at 8 a.m., the initial rate is fourteen hours; and then if they continue to be apparent until Thursday at 8 a.m. the final rate is sixty-two hours. With such a rapid rate the stool is always soft and formless, like Figure 3. On the other hand, when the seeds pass through the gut at a moderate speed, with an initial rate of about twenty-five, and a final rate of about ninety-seven hours, the feces are formed with marks, as shown in Figure 4. And finally with a slow rate of about sixty-two and one hundred and thirty-four hours, the feces are entirely formed in discrete masses or units, as shown in Figure 5.

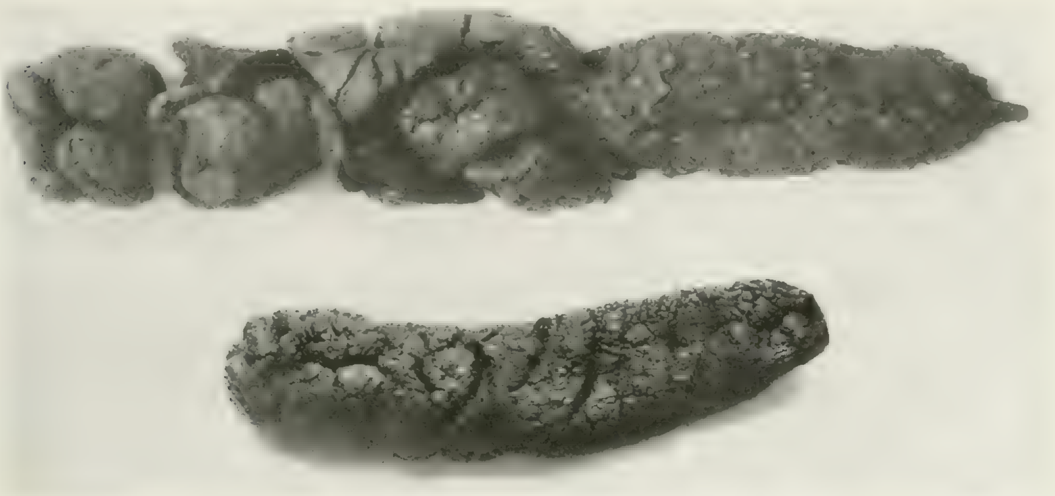


Fig. 6. Two specimens illustrating an accelerated intestinal rate.

These figures represent a uniform speed of the intestinal contents in their passage during the test; but very frequently the rate varies and becomes accelerated or retarded, and then there is a corresponding change in the form of the feces. The specimens shown in Figure 6 illustrate an accelerated intestinal rate. Such dejections are always large, and exhibit several different features, as units, marks and formless portions, and show a change in the initial rate from sixty to twenty-four or even fifteen hours. Then in Figure 7, specimens illustrating a retarded rate are shown; and indicate a change from fifteen or twenty-four to thirty or thirty-six hours. These specimens are always small and are composed of small units.

The object of this study has been not only to correlate the intestinal rate with the form of the feces, but actually to retard the rate, in order to get patients with eczema and psoriasis on a unit basis, and in this way relieve intestinal indigestion.*

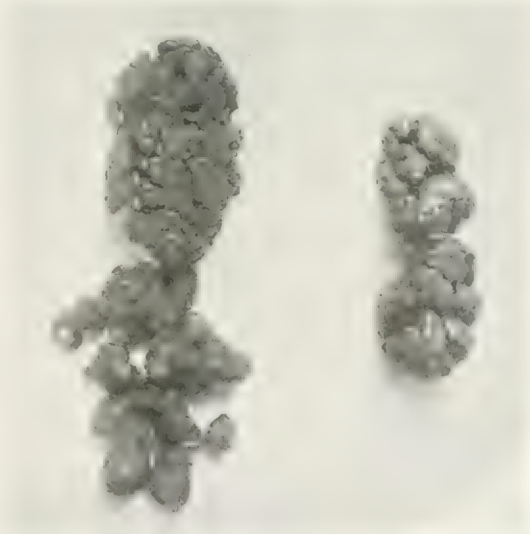


Fig. 7. Two stools indicating a retarded intestinal rate.

---

* A paper on Intestinal Indigestion in Eczema and Psoriasis is being prepared.

The treatment consists in refining the alimentary mixture; by this means the intestinal rate is retarded, as shown in Table 1. We have been led to believe that a slowing of the intestinal contents is always the cause of autointoxication, and a great many secondary conditions of disease. This form of food poisoning undoubtedly does occur, but evidently in those with an unrefined mixture. From a study of a few of these patients such a mixture generally evokes a rapid intestinal rate.

Some of the estimates actually obtained are as follows:

TABLE I

A			B		
Date		Rate	Date		Rate
22	X	15–39	18	VII	12–23
29		15–39	25		15–88
6	XI	16–63	1	VIII	24–X*
13		16–63	8		49–118
20		16–85	15		15–117
27		16–64	22		15–102
31	XII	18–85	29		15–X*
28	I	15–89	5	II	63–184
C			D		
Date		Rate	Date		Rate
7	VII	25–96	8	I	63–135
12		24–48	15		63–115
3	X	64–X*	22		87–134
7	I	17–42	29		63–146
29		43–115	5	II	63–146
12	II	44–113	12		63–147
27	III	45–96	19		39–160
24	IV	64–139	26		63–160

* Not observed.

A was a patient with constipation and eczema, who found on refining the alimentary mixture that his movements became more regular, without laxatives, and that the eczema improved. B had psoriasis, and improved on dietary treatment only. C was another psoriatic, who, while on a unit basis and a slow intestinal rate, recovered entirely. At this time he felt unusually well, but got careless about his diet, changed his rate to 17–42 and with the accompanying change in the character of his stool had another attack. Finally he resumed treatment, once more got on a unit basis with a rate of 64–139, and the lesions have disappeared. D is an unusually healthy individual having had a slow rate of about 63–147 for many years. Estimates of the intestinal rate are of practical value in keeping a check on patients having previously been subject to dietary errors, as shown in Table II.

TABLE II

E		
Date		Rate
1	XI	38–145
10	XII	39–148
11	II	50–110
6	III	49–145

The significance of the semisolid form of the feces or diarrhea, as shown in Figure 2, is sufficiently obvious to require comment. The soft and formless dejection with an irregular surface, in contrast with one formed with marks, or more particularly with one of marks and units too, must have some meaning. Such pronounced features in two of the types must be due to some of the functions of the gut; and in order to compare these features with the actions, it is well to review the intestinal motility. In general there are three essential forms of motility; rhythmic segmentation in the small intestine, peristalsis and antiperistalsis in the proximal colon, and haustral churning or segmentation in the distal colon. These functions are shown diagrammatically in Figure 8. The action of the small intestine need not be taken into consideration, as it probably does not influence the form of the feces. On the other hand, after the soft and

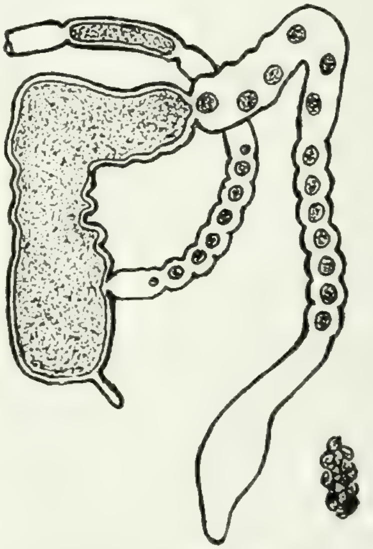


FIG. 8. A diagram of the intestines illustrating the three most essential forms of motility: rhythmic segmentation in the small gut, peristalsis and antiperistalsis in the proximal colon and haustral segmentation in the distal colon.

pultaceous material has been kneaded back and forth in the proximal colon, it is formed into discrete masses by the action of a series of constricting rings in the intermediate colon, as shown in Figure 9. Then these small masses or units are evidently a sign that the ingested material has completed peristalsis and antiperistalsis in the proximal colon. In the distal colon the units travel slowly onward by the movement of Fischl and Porges, but are once more acted on by constrictions of the gut in haustral churning or segmentation. Case[7] says this process is similar to rhythmic segmentation; and so the marks or lines shown on the units and specimens formed with marks are evidently due to this function. Accordingly the significance of the forms of the feces without doubt is thus; the unit form of the feces is an indication that the intestinal contents have completed the three essential forms of motility of the gut; the one formed with marks is an indication of rhythmic and haustral segmentation. Such a contention is not only borne out by figures on the intestinal rate, but also by success in the treatment of cases. Specimens formed with marks will appear after a while if the patient follows directions; but the unit form of the feces requires long-continued and exacting efforts to produce.

Is it possible to consider the significance of the feces further, and call one normal, and the others abnormal? The soft and formless dejection is a common type. On the other hand, the unit form of the feces is in the first place similar to the normal form of the higher animals. In the second place it conforms to the physiology of the gut; and in the third place the requirements necessary to produce it are exacting, and when not fulfilled the stool changes to a soft and formless condition, as shown in Figure 6. Finally, individuals found regularly on a unit basis are unusually healthy, and those changed to this basis by treatment—without the aid of any other measures—have improved in health, and been relieved of very resistant forms of eczema and psoriasis. Therefore it is difficult not to say that the unit form of the feces is normal; and that the intestinal rate of about sixty and one hundred and thirty-four hours always accompanying this form, is normal. In this way the form of the feces affords a very definite and immutable means of determining two heretofore unrecognized conditions of the body. One is intestinal indigestion as determined by the soft and formless stool. Such a condition is always associated with malnutrition and may be with an excessive or peculiar putrefaction of the intestinal contents; and these factors may be the cause of secondary conditions of disease. The other is an improved state of well-being, as determined by the unit form of the feces. In this condition the individual evidently receives the nourishment in amount and kind that should be obtained from the food; and to keep on such a basis should prevent some secondary conditions of disease, in the maintenance of a harmonious and healthy body.

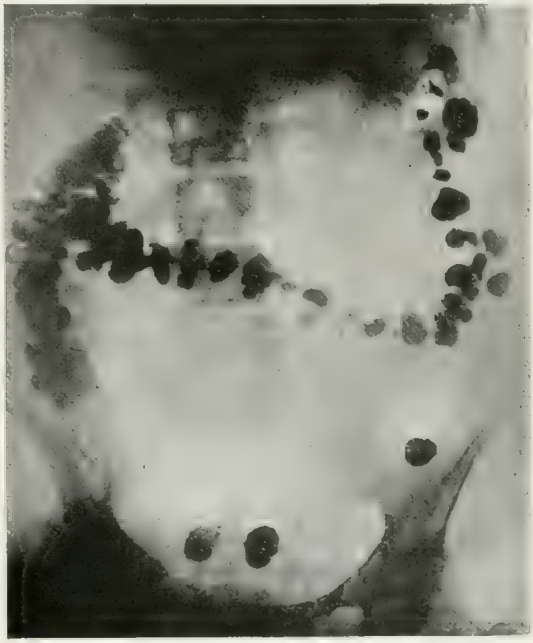


Fig. 9. A roentgenogram by Dr. James T. Case taken fifty hours after the ingestion of a barium meal, and showing a disposition of the colonic contents similar to the previous diagram.

In conclusion, it is evident that there is a definite relation between the time taken by the aliment to pass through the gastro-intestinal tract and the form of the feces. For stools having an initial rate of fourteen hours and a final rate of sixty-two hours are soft and formless; those with a rate of twenty-five and ninety-seven hours are formed with marks, and those at about sixty-two and one hundred and thirty-four hours are entirely composed of units. Then accelerated and retarded rates are associated with stools of distinctive features. Again these rates and features of the feces evidently bear some relation to the intestinal functions in operation; and as one entirely composed of units is similar to the normal form of the higher animals; as it conforms to the physiology of the gut; as the requirements necessary to produce it are exacting and when not fulfilled it changes to a soft and formless mass; and finally, as certain patients, changed by a course of treatment from dejecting a soft and formless stool to one entirely composed of units, become relieved of some very resistant forms of disease; it is difficult not to say that the unit form of the feces is normal. Accordingly the form of the feces affords a means of determining two heretofore unrecognized conditions of the body; one is intestinal indigestion with soft and formless stools; the other is an improved state of well-being with fecal units and an intestinal rate of about sixty-two and one hundred and thirty-four hours always accompanying this form.

BIBLIOGRAPHY

1. Cannon, W. B. The Mechanical Factors of Digestion. New York, 1911, p. 2.
2. Hurst, Arthur F. Constipation and Allied Intestinal Disorders. London, 1921, p. 9.
3. Case, James T. Roentgenologic aspects of intestinal stasis. *Med. Clin. Chicago*, No. 5, i, 849.
4. Barclay, A. E. The Alimentary Tract. New York, 1917, p. 119.
5. Straus, H. *Arch. f. Verdauungskr.*, 1914, Vol. 20.
6. Burnett, Francis L. Fecal units and intestinal rate, a basis for the study of health and intestinal indigestion. *Boston M. & S. J.*, 1921, clxxxiv, 376.
7. Case, James T. Loc. cit., p. 847.

A BUCKY DIAPHRAGM WITH WIDE SLITS

BY W. L. SNIDER, M.D.

HOT SPRINGS, ARKANSAS

Mr. R. B. Wilsey, in a recent article on the Bucky diaphragm, has demonstrated that the efficiency of the diaphragm depends entirely upon the ratio of the width to the depth of the slits, but not upon their actual size. Also that the definition obtainable with the diaphragm depends chiefly upon the distance between the object and the film. Therefore, to conserve detail the grid must be kept as thin as possible, which necessarily limits the size of the slits.

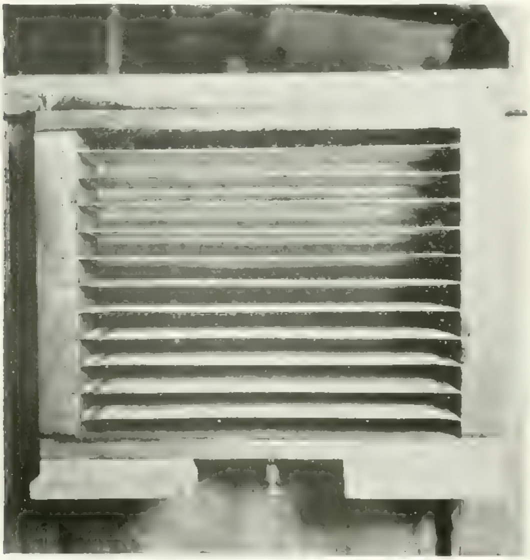


Fig. 1. The grid with the screen removed.

It is well known that definition is improved as you increase the distance between the plate and the target, especially for objects somewhat distant from the plate.

By using a plate-target distance of 7 ft., a grid consisting of slits 1 in. wide and 4 in. deep may be used without any loss of detail.

Such a grid may be made stationary, as the opaque plates are so far apart that their shadows do not interfere with vision.

This grid was devised to assist in making fluoroscopic examination of the heart and vessels. Working at 7 ft., natural-size tracings may be made directly on the screen.

The opaque plates are made of 18-gauge sheet iron, as they are stiff enough to stay in place without intervening material to support them.

REPORT OF THREE UNUSUAL ABDOMINAL CASES*

BY CARL H. PARKER, M.D.

PASADENA, CALIFORNIA

THE first case is a mesenteric cyst with the rather unique feature that it casts a very definite shadow on the *x*-ray plate, thus making a pre-operative diagnosis possible.

In practically all of the previously reported cases of mesenteric cyst, it was only at the time of operation or autopsy that the diagnosis was made with any degree of assurance. Most of the cases come to the attention of the surgeon either because of an acute intestinal obstruction simulating, in many instances, an intussusception in a child, or as instances of abdominal mass, without features that are sufficiently characteristic to make pre-operative diagnosis certain. In several of the reported cases, roentgenological examination has been of little or no assistance, because the cyst contents did not cast a shadow differentiating the cyst from surrounding structures outside the bowel. Fortunately, in this instance, the cyst shadow was very easily seen.

I wish briefly to review the four different ways in which mesenteric cysts are thought to arise. They are all the result of embryonic accidents, but these accidents may be of different kinds:

1. Cysts developing in misplaced structures derived from retroperitoneal organs.
    (*a*) Germinal epithelium
    (*b*) Ovary
    (*c*) Wolffian body
    (*d*) Mullerian duct.
2. Dermoid cysts.
3. Cysts of intestinal origin.
    (*a*) By sequestration from the bowel during development.
    (*b*) From Meckel's diverticulum, when it arises from the convex side of the bowel.
4. A fourth cause has been suggested because of the chylous character of the cyst contents in many cases, i.e., that the cyst develops from one of the primary lymphatic sacs which are the embryonic beginnings of the entire lymphatic system.

In support of the idea that some mesenteric cysts are of intestinal origin is the observation of Lewis and Thyng: "There is a regular occurrence of intestinal diverticula, especially in the upper part of the small bowels, in the embryos of the pig, the rabbit and man." Quoting further: "Such a diverticulum, growing down between the layers of the mesentery and then becoming sequestrated, might easily be the basis of a mesenteric cyst, or persist as one of the diverticula seen in adult life."

If these theories represent facts, then the 3 cases I wish to present are all instances of embryonic accident, and are therefore related, although widely different in their manifestations clinically:

1. A case of mesenteric cyst.
2. A case of patent omphalomesenteric duct.
3. A case of diverticulum of the small bowel arising at the junction of the duodenum and jejunum.

CASE I. Male, aged four years.

Clinical History. Three weeks ago the patient ate some green plums, which upset his digestion for a few days. He vomited after castor-oil, had some fever and felt "dumpy." Since he recovered from that trouble he has been apparently well. Two years ago he had a similar attack, at which time the physician, Dr. Ball, discovered a mass in the abdomen, close to the navel, about the size of a big walnut. That mass is still present. It feels smooth and firm, and can be moved about through a diameter of a couple of inches, although it feels as though it were fairly well fixed at the base to the mesentery, or some such structure. It is now, in the father's opinion, not quite so prominent as it was two years ago, because then a localized enlargement of the abdomen could be seen. At no time has the boy had any serious illness. He has had no accident, and does not complain of pain or tenderness in the epigastric region. He has palpable glands in both cervical regions, one or two under each arm, and a few in each groin. His color is good. He has gained well in weight, height and strength. He has five brothers and sisters, all of whom are well. Parents are well, and have not been sick since he was born. He has lived all his four years in Los Angeles County. The examination is made to determine the character of the mass within the abdomen. The boy is apparently perfectly well and free from all symptoms which might fairly be attributed to the mass.

---

* Paper submitted leading to membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

Radiographic Findings. Plates were made of the abdomen prior to the administration of the opaque meal. In these plates two abnormal shadows are noted. The larger is nearly circular, and 4 cm. in diameter. The smaller is elliptical, 25 × 18 mm. in size. Both of these shadows present a density which is comparable to the bone of the transverse processes of the lumbar vertebrae. The density is not uniform. On the larger of the two shadows there is a circular outline that suggests a nubbin. Taking plates prone and supine, the prone position gives much the clearer plate, which is evidence that the mass lies to the front, where it seems, on palpation, to be just within the abdominal cavity.

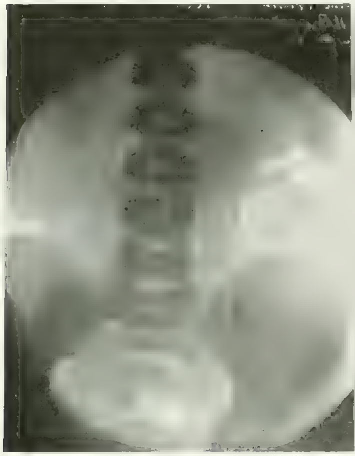


FIG. 1. Mesenteric cyst before the administration of barium. The metal markers outlined the large cyst with the patient on his back. The movability of the cyst is indicated by the change in position, as shown in the illustration with the patient prone.

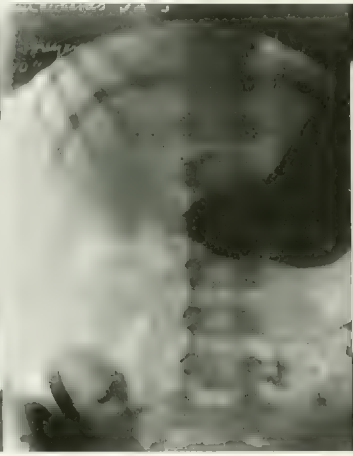


FIG. 2. Mesenteric cyst. Stomach outlined by barium meal.

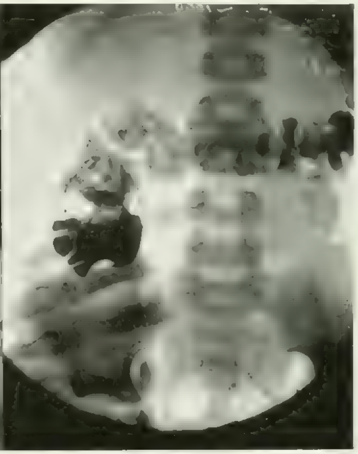


FIG. 3. Mesenteric cyst. Colon outlined by meal. The cyst was made more distinct by palpation during the making of the plate.

The opaque meal, of sweet milk and barium, was administered. No abnormality or defect of the stomach could be detected. The mass lies below and not attached to the stomach. As the meal passed through the small intestine, there was no evidence of obstruction, and the intestinal coils surround the mass as though they were displaced by the mass itself. The mass is in close relation to the right half of the transverse colon. It can be readily pushed away from the cecum, but when pressure is made on the upper portion of the mass in an effort to displace it downward, one point of the transverse colon is adherent at one point to the mass. It is evidently not obstructing the passage of the food content through the bowel. In the lateral view the mass shows with its posterior border about in line with the front of the vertebral bodies. The appendix shows filled with barium, but it is not fixed or tender.

The interpretation of the findings is as follows: The circular shape is evidence that we are dealing with a cystic growth. It is movable. An apparent posterior attachment shows a relationship to the mesentery. The regular borders and the large size of the greater of the two masses, the lack of fixation and the uniform density are evidence against these shadows being due to mesenteric glands.

Radiographic Diagnosis. Mesenteric cyst.

Operative Findings. Operation by Dr. J. H. Breyer. At operation a multilocular cyst of the mesentery of the small intestine was found. It was not adjacent to the bowel, but was completely surrounded by the layers of mesentery. The contents closely resembled sebaceous material, though no analysis of the contents was made. No calcification was present. The cyst was enucleated, and the patient made an uneventful recovery.

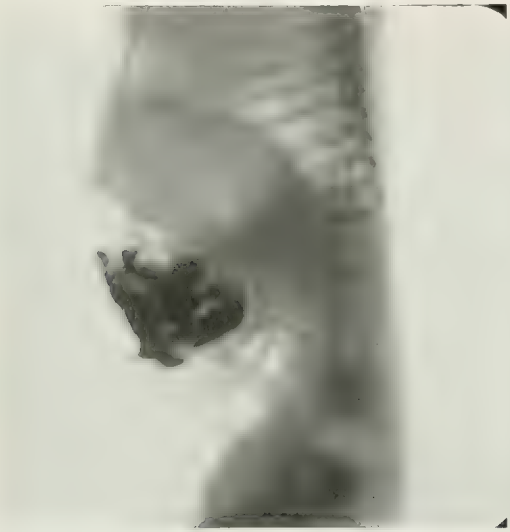


Fig. 4. Patent omphalomesenteric duct. The barium has been injected through the opening at the umbilicus. The barium appeared to enter a normal coil of small intestine immediately below the umbilicus.

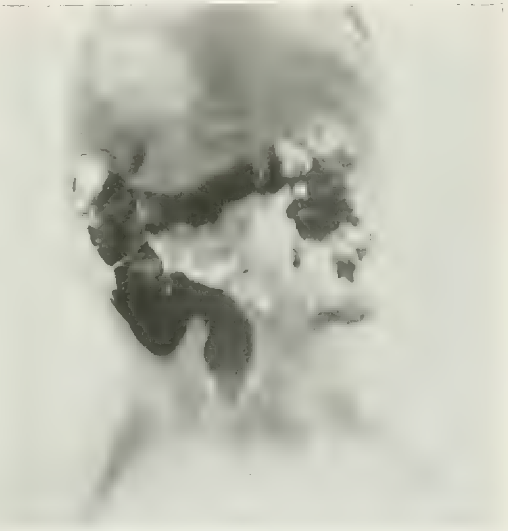


Fig 5. Patent omphalomesenteric duct. The injected material has passed into the large bowel. Barium is still to be seen in the duct as it passes through the abdominal wall.

Postoperative Pathological Report. "Examination of the cyst and lymph-node removed has been made with the following results: The lymph-node shows simply an inflammatory hyperplasia. The cyst is made up of very dense, coarse fibrous tissue with a slight amount of granulation tissue on the inner surface. In this granulation tissue was found a large amount of blood corpuscles and a considerable amount of altered blood pigment, so there must have been considerable hemorrhage into the cyst before operation. There was nothing to indicate the nature of the processes to cause a cyst." Dr. S. P. Black.

Case II. Infant, aged three weeks.

Clinical History. This patient was delivered three weeks ago in normal manner. When the cord separated, a few days later, small amounts of fecal material began to escape from the umbilical stump. There has been a protrusion looking like everted bowel about $\frac{3}{4}$ in. in length from the umbilicus. The baby is gaining well on breast milk.

Radiographic Findings. A meal of barium and breast milk was administered, but this passed through the intestinal tract without our being able to differentiate the abnormal loop from the other intestinal coils. Accordingly, a barium mixture was gently injected through the umbilical opening. Figure 4 shows where the barium passed into the distended loops of intestine. The part of the bowel filled by the barium would appear to be the mid-portion of the small intestine, as shown by the barium mass and the position in the abdomen. The omphalomesenteric duct or patent Meckel's diverticulum leading from the umbilicus to the bowel could not be identified because the barium appeared to enter the small intestine immediately below the abdominal wall. Figure 5 shows the condition several hours later, with the injected material principally in the large intestine, and a small amount of barium in the abnormal loop. This case has not been operated upon, hence further findings are not available.

Case III. Male, aged fifty-two, miner.

Clinical History. A diverticulum of the small intestine at the junction of the duodenum and jejunum is worthy of report because of the difficulty that was encountered in differentiating the diverticulum from a ruptured gastric ulcer with an accessory pocket. The patient was referred for examination principally because of a very severe persistent asthma, which had been present for approximately three years. His history, so far as it relates to the digestive tract, was as follows: He has had more or less trouble with his digestion ever since he can remember, in the way of constipation. He has had an inadequate movement about every day, and every few days was obliged to take a pill or an enema in order to clear himself out. When his bowels were "tied up" he would frequently vomit bile, have a sour stomach and a lot of gas. He has never thrown up blood or passed blood by bowel, that he recognized. He has had no particular pain or soreness in the abdomen, and never has thrown up food remnants taken hours previously. He has been in mining camps for years, where he has lived either in eating-houses or alone. In either case he was forced to eat what was handy. He has been a periodical drinker. After a week or two of drinking he would have a bad stomach, but, he stated, no worse than it has been at other times. No clear account of relief by food taking or other trouble characteristic of ulcer of the stomach could be obtained.

Radiographic Findings. The barium meal passed into the stomach without evidence of obstruction. Only a few swallows of barium had been taken when the screen was centered over the stomach and the patient was instructed to drink the rest of the buttermilk. As the meal began to fill the stomach and distend the antrum, it was noted that the stream coming down the lesser curvature deviated somewhat to the left an inch or two below the cardia, while the apparent outline of the stomach extended too far to the right at this point. Directly opposite on the greater curvature was a deep incisura of spasm that could be relaxed for a few seconds by pressure and then recurred. On the lesser curvature side and behind there seemed to be a pouch of the size of an egg, which filled about one-half with barium and showed a distinct fluid level topped by a gas-bubble. The main part of the meal showed the usual gas-bubble at a much higher level toward

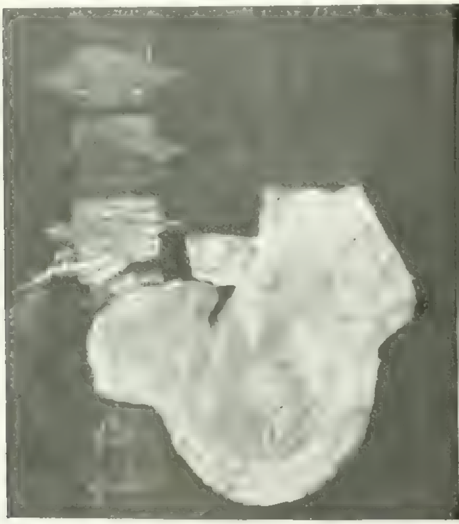


Fig. 6. Diverticulum of the third portion of the duodenum. Tracing of stomach and diverticulum filled with barium, patient erect. The fluid level in the stomach is above that in the diverticulum.

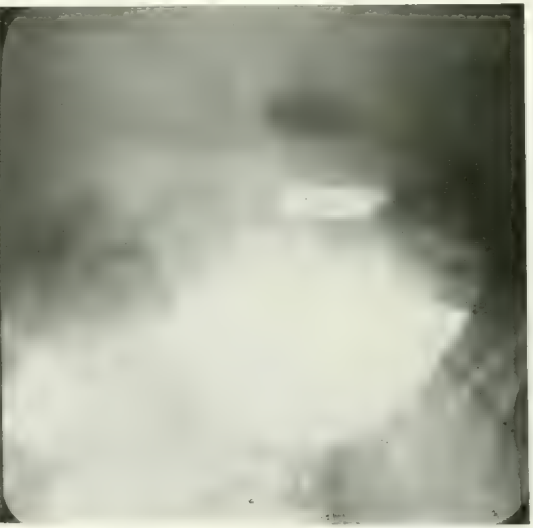


Fig. 7. Diverticulum of the third portion of the duodenum. Made one hour after administration of the barium. The fluid level in the diverticulum is now well above that in the stomach. Patient erect.

the cardia, and as digestion and emptying of the stomach progressed, at a much lower level than that of the pouch. Figure 6 shows the appearance that was noted immediately after the taking of the meal, with the patient in the erect posture. The fluid level of the stomach is seen distinctly above the fluid level in the pouch, which is about half full. By making pressure with the hand the pouch half full of barium could be outlined as entirely distinct from the rest of the stomach, but no connection between the stomach and the pouch could be demonstrated. In the prone position, the pouch appeared as a protrusion on the lesser curvature side, but not distinct from the rest of the stomach. No tenderness was elicited by pressure. The meal began to pass through the pylorus immediately, and so far as could be noted the pyloric region and cap were not involved. In Figure 7 it will be noted that a considerable amount of barium has passed through into the small intestine, that the pouch is about one-fourth full, and that it presents a distinct fluid level well above and separate from the fluid level in the main portion of the stomach. In Figure 8, made at twelve hours, the bulk of the meal was seen in the large intestine. Considerable residue was still present in the pouch. Below the stomach no evidence of pathology was encountered in either small or large intestine, as the meal passed through. On May 21st, several days after the other inspection, a second meal was administered. Barium water was given first, then the usual buttermilk mixture, and with neither was there an immediate filling of the pouch. A decided spasm was present at first, holding the meal in the cardiac portion of the stomach, but soon a relaxation allowed the meal to fill the antrum. A plate made at this time showed a perfectly normal stomach outline. By pressure to the right and slightly upward, the pouch was partly filled, and appearances exactly duplicating that found at the first meal were noted. Three and a half hours after this meal the body of the stomach was almost entirely empty, but the pouch contained a residue $2\frac{1}{2}$ in. in diameter. At six hours the stomach was empty, and a barium shadow an inch across persisted at the site of the diverticulum.

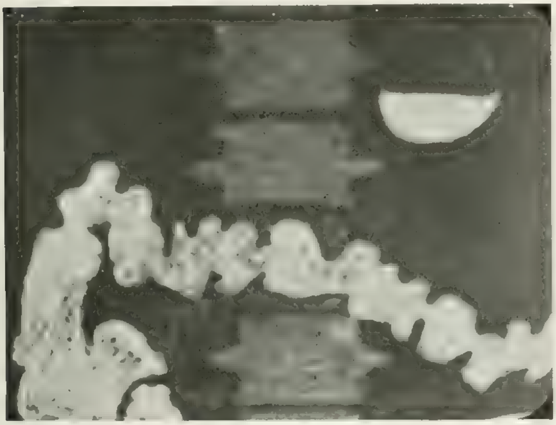


Fig. 8. Diverticulum of the third portion of the duodenum. Tracing of plate made at twelve hours. The meal is in the large intestine while the diverticulum still contains some barium.

An examination of the chest shows marked thickening of both hilus regions, but no shadow indicating pathological processes in the parenchyma of the lung. Films of the few remaining teeth in the lower jaw are negative for abscess, but present evidence of a considerable absorption of bone at the alveolar margin, due to a pyorrhea process.

Radiographic Diagnosis. Ulcer of the stomach with accessory pocket posterior to the stomach.

Further History. At operation a few weeks later, when the stomach was exposed, both the anterior and posterior walls of the stomach were carefully inspected, and no appearance indicative of pathology could be discovered. A careful search of the duodenum at first revealed nothing unusual. However, traction on the jejunum brought down a diverticulum, which extended upward and to the right from the bowel just where the duodenum emerges to form the jejunum. This diverticulum was of approximately the same caliber as the jejunum. It was about 4 in. in length, and left the small bowel at approximately a right angle. The stoma was of the same caliber as the rest of the diverticulum. No inflammation was noted about the diverticulum, which was entirely surrounded by peritoneum, so that it was easily clamped and removed in much the manner that is ordinarily used in disposing of an appendix.

The patient made an uneventful recovery from the operation. Since that time he has returned to the desert, and in spite of repeated efforts to learn of his condition, no replies have been returned. No data is available as to the effect of the removal on either his digestion or his asthma.

This case was of particular interest because it so clearly simulated the findings seen in perforating ulcer of the lesser curvature or posterior wall of the stomach with accessory pocket. I believe that had I been alert to the possibility of encountering a diverticulum in this location, a correct diagnosis could have been made by roentgen examination. It is also interesting to note that the diverticulum was hidden beneath the superior mesenteric fold, and was found during the surgical exploration only after the most careful examination of this region, in an effort to explain the roentgenographic findings.

LOCALIZATION OF BRAIN TUMORS BY CEREBRAL PNEUMOGRAPHY*

BY WALTER DANDY, M.D.

BALTIMORE, MARYLAND

THE results in surgery of the brain, as indeed in all branches of surgery, have been greatly modified by inadequate and inaccurate knowledge of the situation, as well as by the character of the lesion. It is doubtless known to all of you that tumors of the brain are exceedingly difficult to localize. Usually we may say with a fair degree of assurance that the patient has a tumor of the brain, but the localization of the tumor requires all the resources at our command. The great silent areas of the brain—silent because we do not yet know their function—harbor these growths of tremendous size and give to the host no indication of their situation by signs or symptoms.

The roentgen ray has now become our assistant and it is also our greatest detective. With its aid, I should say practically all brain tumors should be located. A considerable portion of them (as a guess probably 15 to 20 per cent) can be located solely by shadows which the tumors cast, by virtue of calcification and also by the destructive effects upon various parts of the skull. In other cases the evidence, while not pathognomonic, is helpful and corroborative. With these results, however, you are all thoroughly familiar.

In at least 35 per cent of brain tumors the injection of air into the ventricles of the brain aids tremendously the function of the *x*-ray, and by its usage we can locate the remaining group of tumors which cannot be located in other ways It is the results in this particular group—about 35 per cent—which I wish to bring before you.

For this procedure air is substituted for cerebrospinal fluid; that is, fluid is withdrawn from the cavities of the brain and air is substituted, thereby changing the density of certain parts of the cranial chamber. To do this, fluid is withdrawn from a lateral ventricle and air injected in equal amount. The air casts a shadow in precisely the same way as opaque media produce shadows in the genitourinary or the gastrointestinal tracts, shadows being of course due to differences in density. From the changes which are found by contrast with the normal cerebral ventricle in size, shape and position, we are able to deduce the situation of the tumor; for all tumors which give signs of intracranial pressure will produce some change in the shape, size or position of one or more of the ventricles. By that I do not mean that all brain tumors distort or change the size, shape and position of the ventricles, but that all brain tumors *which give symptoms of pressure* produce one or more of these changes, which should make a diagnosis possible.

Brain tumors give rise to two types of signs or symptoms: (1) those of localizing character, (2) those of general pressure. If the patient has localizing manifestations, the localization of the tumor is made without the use of the *x*-ray or without the use of air injection. If there are no localizing symptoms, the only other symptoms which the patient can have are those of pressure. Therefore, it can be said that practically all brain tumors *which give symptoms* can be localized, either by the localizing symptoms or by the use of the *x*-ray with or without the injection of air.

---

*Read at the Fourth Annual Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

To Dr. Baetjer is due a large share in the credit of developing this procedure. He has always been most eager and willing to clarify the difficulties and I feel that without him we would have had a very difficult course to pursue.

We have seen tumors of the frontal, temporal, parietal and occipital lobes; tumors in the ventricles; tumors in the cerebellum and brain stem.

There is one group of tumors in which the use of air is less absolute. This is the group which gives a bilateral hydrocephalus and in which two lateral ventricles communicate freely. All we can say from the ventriculograms is that we have a lesion between the aqueduct of Sylvius and the foramen of Magendie, but with very few exceptions this is sufficient information to allow us to find the tumor at operation. If we know that a patient has hydrocephalus, then we should be able to find the tumor at operation; that is, the operations which we now have are adequate to find practically any tumor.

Just a word as to the procedure. It is very dangerous. There has been a tremendous mortality from its use. However, if judiciously used and only by one thoroughly skilled in intracranial surgery, the danger is minimal. I had three deaths at the beginning of my series. Since then, I have had none. If properly handled, it should carry very little danger to the individual; and certainly the danger in proper hands is small compared to the dangers attending cranial operations based upon guesswork.

In the treatment of brain tumors, as in surgery elsewhere, we must have an accurate diagnosis and a precise localization. If we do not have these, our surgery is bound to suffer. The treatment of brain tumors particularly calls for very formidable procedures, which should not be misplaced.

There are many pitfalls in interpretation of *x*-ray findings. It is certainly not a simple foolproof interpretation; it requires much experience. We have made mistakes in our interpretation and it is only as our experience widens that we have attained an assurance that the localization can be made with a high degree of certainty and precision.

For practical purposes we shall deal principally with the ventricular system. You will note the 4 cerebral ventricles, 2 lateral ventricles, the 3rd ventricle and the 4th ventricle. It is also necessary to understand the physiology of the circulation of cerebrospinal fluid. All cerebrospinal fluid forms in the ventricles of the brain but does not absorb there. It absorbs outside of the brain. For this reason, if there is a tumor blocking any part of the ventricular system, there will be a dilatation of the ventricular system ahead of that obstruction. If we were to trace the course of a drop of fluid after it forms in the anteriormost part of the ventricular system until its absorption, we would find it passes through the lateral ventricle to the foramen of Monro; if the foramen of Monro is blocked, this entire lateral ventricle must distend because there is no other outlet for the fluid, exactly as an obstructed ureter causes distention. Continuing the normal journey of the drop of fluid, it passes through each foramen of Monro into the 3rd ventricle, and from the 3rd ventricle there is only one point of exit—the aqueduct of Sylvius. All fluid which forms in both lateral ventricles and the 3rd ventricle must pass through the aqueduct of Sylvius. If, therefore, you have a block in the aqueduct of Sylvius, the 3rd and both lateral ventricles must become distended. There is no other possibility of escape for this fluid. Again continuing the course of this drop of fluid through a patent aqueduct of Sylvius, we find that it enters the 4th ventricle; and leading from the 4th ventricle there are three openings, two foramina of Luschka and one of Magendie. From these the fluid pours into the cisterna magna, whence it is distributed into the absorbing spaces of the brain on its exterior. The fluid passes downward into the spinal canal and upward into the subarachnoid spaces which cover the whole brain. If you understand the absorbing parts of this circulatory system and understand that the fluid must reach them to be absorbed, you can understand why dilatation of the ventricles results from tumors; and therefore, when you get dilatation, you can infer the location of the obstruction which causes it. The location of that obstruction will, of course, be the location of the tumor.

In perspective, the ventricular system will actually appear. Each lateral ventricle occupies approximately the center of a cerebral hemisphere, and you can see the relative positions of the foramina of Monro, the 3rd ventricle, the aqueduct of Sylvius, the 4th ventricle and the foramina of exit at the base (the foramina of Magendie and Luschka). The spinal fluid in the cerebral ventricles has only these three outlets (closely approximated) for the escape of all the cerebrospinal fluid.

For practical purposes the vast majority of tumors are diagnosed by the effect which the tumors have on the two lateral ventricles. The 3rd also has an important field, as well as the 4th, but most are localized through the effects on the two lateral ventricles.

You can see that if there is a tumor in the frontal lobe, the anterior horn of this ventricle will be compressed. If that tumor becomes large enough it will obliterate this part of the ventricle and close the foramen of Monro. If, then, air is injected into the ventricle, it could not escape from or into this ventricle (depending on the ventricle injected) because the ventricle is occluded. Complete occlusion of the ventricle occurs in a large percentage of tumors in this region. This, of course, represents relatively late stages of the tumor's growth.

Obstruction in any point of the ventricle will be demonstrated by the inability of the air to pass beyond it. An obstruction in a ventricle would cause distention of the ventricle ahead of it and would have no effect upon the size of the ventricle behind the tumor. A tumor in the 4th ventricle would produce hydrocephalus in the same way, but there would be this striking difference: the lateral ventricles would not communicate with each other. The difficult region for precise diagnosis is between the aqueduct of Sylvius and the foramen of Magendie.

To describe the operation necessary for the procedure: A small opening is made on each side of the skull. We always make two openings, one for each lateral ventricle. A large tumor will often occlude one ventricle so that it cannot be reached, but the other ventricle will usually be attainable. The posterior opening is chosen because this part of the ventricle is largest and easiest to reach.

As to the method of injection of air, the needle is inserted through the skull opening into the posterior horn of the ventricle. Cerebrospinal fluid is aspirated from the ventricle and ejected; unsterilized air is aspirated into the syringe and forced into the lateral ventricle. An amount of air equal to the amount of fluid removed should be injected; by turning the head in the proper way the air can be shifted at will to any part of the ventricular system.

DISCUSSION

Dr. Kerr. It is a great pleasure to be here tonight as your guest. I appreciate the opportunity not only to be with you, but also to discuss Dr. Dandy's valuable paper on cerebral pneumography.

Dr. Dandy has given us a very brilliant addition to cerebral surgery in establishing and proving the value of air injection as an aid to the localization of brain tumors. As he so aptly said, all surgery is dependent on diagnosis; and the more exact and more perfect the diagnosis, the better the resulting surgery.

We all feel that surgery of the brain is just on the threshold of a brilliant future. It is by the researches of such exceptional students as Dr. Dandy that neurosurgery can be improved. Step by step the high mortality and unsatisfactory results can be eliminated. As in surgery elsewhere, such results demand early diagnosis—not a diagnosis of brain tumor when the patient is blind, paralyzed and helpless, so that if a tumor is removed only a useless life is prolonged, but a diagnosis which permits us to localize the lesion and remove it in the early stages and return our patient to a useful life.

Dr. Dandy's ventriculography, as he first termed it, was given to the profession some years ago. Sufficient time has elapsed to allow an estimate of its worth. We must decide whether cerebral pneumography does or does not help in the localization of brain tumor. We have to balance its value against its danger; we must study its faults or shortcomings, if it has any, and elaborate on the technique to improve the results or reduce the mortality. Although it is too early for many of us to speak in this way, because we have not had the experience or developed the skill of Dr. Dandy, we can make certain statements.

There is no doubt that a certain proportion of cerebral tumors are not definitely localized by neurological studies. If cerebral pneumography will clear up the diagnosis in this group, we can then say that all tumors are localizable. It that true? In Dr. Dandy's hands it is, but in the hands of other surgeons who do neurological work, I do not believe it is. I do not believe we have reached the stage where we can localize by cerebral pneumography all the cases which are not definitely localizable by neurological studies. There are cases where cerebral pneumography will not give definite localization. There are cases where cerebral pneumography may even be misleading. We know that there are abnormalities of the ventricles; that, particularly in the posterior horn, there may be variations from the normal that may lead us to an exploration that proves negative.

I have had two such cases: one in which I felt sure of the position of the tumor. An exploration in that region was negative. In the other case, I was also misled by a posterior horn defect. We now know that there are variations from the normal that we must beware of and must consider in localizing occipital lobe tumors. In the large tumors that make gross deformities of the ventricles, the vast majority are so gross that they produce definite neurological symptoms that will suggest the localization without pneumography.

Where the localization is not clear-cut by other studies, or where there is a question between two possible sites, then cerebral pneumography should prove out one or the other localization. In cases where the lesion is small, where it has not grown to a size to produce gross deformity of the ventricle, we will not get the same definite and gross evidence as we will in the large tumors. If the tumor is in the so-called silent area, we may have no neurological signs of its location. It is in these cases that cerebral pneumography may indicate a successful exploration where we may hope for radical surgery early enough to return our patient to a useful life.

Now as to the dangers. In the hands of other neurological surgeons—again contrasting them to Dr. Dandy—there is a mortality. This is difficult to estimate, but from personal reports it is roughly somewhere in the neighborhood of 3 per cent. In my experience the mortality is higher in hydrocephalic cases. We must remember that when we remove cerebrospinal fluid which has been under pressure from the dilated ventricles of hydrocephalus, pressure has been exerted on the choroid plexus. Just as in the evacuation of any obstructed secreting gland in the body, when the pressure is removed the secretion is re-established, and it perhaps re-establishes at a relatively greater rate than had occurred before. Therefore, if we remove the fluid from a dilated ventricle whose choroid plexus has been under pressure, and replace it by a much more elastic medium, air, the choroid plexus returns to function—perhaps increased function—and we have a rapidly increased pressure in the dilated ventricle. I feel it is important, therefore, in these cases, to remove the air after the roentgenograms have been obtained and your records made. One of my fatal cases died, I feel sure, from this occurrence. Another case showed marked increase in pressure after a cerebral pneumography, but on the removal of the air came around to normal again.

If cerebral pneumography has a mortality of say 3 per cent in the hands of the average neurological surgeon, it must and will undoubtedly have a larger mortality among general surgeons. We must not allow cerebral pneumography to suggest to the uninitiated a rule of thumb and simple way of locating brain tumors. We must warn of the mortality and the need of experience in making as well as interpreting cerebral pneumograms.

In cerebral pneumography we have a distinct addition to the study of the location of brain tumors. The whole thing is a brilliant conception and I feel the profession joins me in most hearty congratulations to Dr. Dandy for his contribution.

Dr. Baetjer. Dr. Dandy was kind enough to say some very nice things about the work that the *X*-Ray Department has done, but I would like to have it understood that the entire conception of this work is his own. The question of position, the question of filling the ventricles, the question of emptying the ventricles and the various ways in which the head is placed are entirely Dr. Dandy's ideas. I have been fortunate enough to see the development of brain surgery for over a period of twenty years, and I realize how inadequate the *x*-ray examination, particularly in the early days, was in many instances to give help to the brain surgeon. I have seen the development of air injection into the ventricles from the very beginning, and there have been a great many difficulties to overcome.

Dr. Dandy has shown you some of the plates and has given you the diagnosis. One might be inclined to think that it was a very easy method of examination. I have seen him study these plates by the hour, day after day, before arriving at any definite conclusion, and then check up by operation. What knowledge I may have of the diagnosis of these conditions has been entirely due to Dr. Dandy. The accuracy of diagnosis in this particular line of work is increasing steadily, and I feel that with the constant study of these cases examined by the air method we will come pretty close to 100 per cent accuracy. I feel that Dr. Dandy's work in this particular line marks tremendous advance in this most difficult line or work.

Dr. Kennedy. Dr. Dandy's work is one of the best contributions that has been made to cerebral surgery in the last twenty years. I think, however, that in order to appraise it properly we would have to know very definitely the details of his whole series.

Dr. Dandy said in his address that only 50 per cent of cerebral tumors are localizable. That, I think, is an underestimate. It is very important, of course, to investigate cases of brain tumor with the utmost exactness, because only very frequent and thorough examinations will bring out the small data necessary to arrive at a diagnosis. We feel as neurologists, and the surgeons I am sure will agree, that our technique in pneumography is very much behind. It has been so much behind that we shall have to take the matter very gravely. A great many of our pneumographs are but shadows chasing shadows. We have not, in the majority of our cases, derived from them the information needed. Dr. Dandy says that 15 per cent of tumors are localizable or discoverable by the *x*-ray, apart from pneumography. That I thought was a rather high percentage; and it differs, if I remember rightly, by 10 per cent from Dr. Dandy's figures published in 1918. At that time I think he said 5 per cent, which even then struck me as a high average, because in my opinion the *x*-ray has been very unfruitful as a method of investigation of tumors apart from a massive tuberculum which, of course, is frequently calcified and throws a very definite shadow.

Dr. Dandy said that by pneumography we will be able to restore the entire balance of those cases which are undiagnosable by neurological examinations. That is rather a wide statement and I am sure that Dr. Dandy does not mean it to be taken quite literally. As Dr. Kerr pointed out, there are natural abnormalities in the shape and size of the ventricles of which one cannot be aware beforehand. Furthermore, there are tumors, a whole series of them, published by Spiller, in which an edema is produced, not around the tumor, but in another part of the brain. This, of course, would deform the ventricle in the wrong place. Then again, there is great difficulty, as was shown by Dr. Dandy, in the fact that a meningitic exudate will block entire ventricular connections as effectively as any tumor. A little while ago I published a series of cases of inflammation of the brain and meninges in the course of which there developed tremendous papillo-edema; in those cases hydrocephalus must have been of quite sudden onset and must have been due to the laying down of meningitic exudate at say the foramen of Monro, producing a bilateral enlargement of the lateral ventricles. Such cases, if pneumographed, would, of course, produce pictures which would look like a posterior fossa tumor, and it is quite difficult to say how one can distinguish between general hydrocephalus and the production of a hydrocephalus in the 4th ventricle.

Dr. Dandy said that this was a procedure which should be employed only in cases not otherwise localizable; but I noticed that he had some instances of tumor of the pineal. That is very astonishing because in our experience, tumor of the pineal produces very clear-cut symptoms by reason of its pressure on adjacent structures.

I would like to say, however, how much I admire his technique in the production of an artificial foramen of Monro. That is as brilliant a piece of surgery as has ever been my privilege to see, and I admire the courageous imagination which prefaced this technique. I believe I admire still more the enterprise and the audacity with which Dr. Dandy attacks the growths when diagnosed. The neurological surgeons have been too much to the Right politically speaking! They have not had enough of the radical about them. Dr. Dandy is on the extreme Left! That is a good thing. It is courageous conduct which will make neurological surgery a living thing.

It occurred to me to give you an instance here and there of neurological diagnoses made on what seemed minute evidence properly appraised. There came to me, while I was listening to Dr. Dandy's paper, the recollection of a girl who came to the hospital under my care with all the general signs of cerebral tumor—very severe headache, severe vomiting, etc. We watched her for a space of three or four weeks, I think, and we had no indication whatever to give us an idea where to operate. We thought of course, that her tumor, if she had one, must be in a large so-called silent area and we examined her particularly for evidence of derangement of the temporal and frontal lobes. She developed fatigability of the right abdominal reflexes. They were not gone, but depressed. One day I showed her a number of objects and asked her to name them and she did so accurately. I took a fountain pen and she hesitated and said, "Now isn't that queer? That is one of those patent pens." On that we operated and found a left-sided temporal tumor. It was inconceivable that a girl who used a fountain pen every day should forget its name and have to use circumlocution, which, of course, is the first thing done when the posterior part of the 1st temporal gyrus is affected. I remember a man who was a police sergeant; he arrested a man guilty of misdemeanor and when he grasped him by the arm to take him to the station he could not release his grasp. He had to take his other hand and undo the fingers one by one in order to get loose. Shortly after that the symptoms continued; when he closed his fist he could not open it again. Then he developed headaches and came under our observation. On that symptom we believed he had a tumor involving the corpus callosum. He developed a slight sign of pressure on the right side. We believed, in view of the fact of this condition in the arm, that he had a lesion. This was proven by operation.

I thought it was worth while to mention such a couple of incidents at random to show that it is necessary to learn each other's language; that a lot of Dr. Dandy's photographs, to the eye not instructed in their significance, might look like cloud effects; their exact significance does not come to the eye. Also in neurological examinations phenomena arise which are of pregnant meaning. The instructed and the uninstructed would have to learn each other's language in order to cooperate; and I have to say that Dr. Dandy's work makes me very anxious to learn his. I think he has contributed enormously to the advancement of his art and science and to ours.

Dr. Pancoast. This is a difficult subject to discuss from the *x*-ray standpoint, because the roentgenologist plays a very small part in the whole procedure, although he does play a very important part. The technique as carried out by the roentgenologist is, of course, a most important one and must be precise and efficient.

We all look upon Dr. Dandy as the man who has developed this method of diagnosis and placed it where it is today, and we must all look up to him for our knowledge of the procedure and the interpretation of our findings.

I can say nothing concerning the technique of the neurosurgeon, but he is absolutely dependent upon the work of the roentgenologist. I have examined just enough cases to know that if the men in this audience go home with the idea that they can start out in this work and be successful, they will find themselves greatly mistaken. You cannot interpret your own plates, for this is a procedure which takes much experience, an accurate knowledge of brain anatomy and familiarity with brain tumor pathology. We have examined 45 cases, but this is a very meager experience, and we have much yet to learn before we can approach anywhere near the accuracy of diagnosis of Dr. Dandy and Dr. Baetjer.

After familiarizing yourselves with brain anatomy, it will be a wise plan to study specimens in a laboratory of neuropathology, in order to learn just what a tumor does to the ventricles. I recently spent an afternoon with Dr. Spiller in the laboratory of neuropathology of the University of Pennsylvania, for this very purpose, and my conception of the subject was considerably modified by what I saw. I was very much struck by the number of specimens of tumor in which there was an enlargement of a part or all of the hemisphere on the side of the tumor, and which Dr. Spiller and others ascribe to an overgrowth of neurogliar tissue. Attention has just been called to this by the last speaker, Dr. Kennedy. Even in the case of small tumors, far away from the ventricles, this overgrowth of tissue seems to encroach upon the ventricles, and is likely to be misleading in the interpretation of the ventriculogram. This condition is found not only in connection with tumors, but is also associated with traumatized areas.

In one brain there was a very striking condition which would undoubtedly have led to error in case cerebral pneumography had been attempted. At about the middle of the lateral ventricle on one side there were some dense adhesions practically dividing it into two portions. Lower down in the ventricular system there were other adhesions causing a moderate internal hydrocephalus. This was a syphilitic case.

The work in our laboratory has been carried out in conjunction with Dr. Frazier's clinic, and his associate, Dr. Grant, and I have worked out most of the cases. We have spent many hours working over cases and trying to improve our technique; but by sitting beside Dr. Baetjer here in this room, I have learned many valuable technical points as Dr. Dandy has proceeded. His technique is quite different in many respects from the one we have employed, and we shall certainly put into practice many of his ideas in the future. We have always placed our plates on the up-side of the head, with the tube under the table. Dr. Baetjer works in the reverse manner. I can readily see, however, that it is absolutely essential to empty the ventricles of all fluid in such a procedure; otherwise air-filling defects due to fluid remaining in the dependent ventricles will give fallacious results.

I have also learned from Dr. Dandy that it is very necessary to tap and inject both ventricles. Many failures we have had can be ascribed to omission of this. Exact centering of the tube and head is essential in order to find slight lateral deviations of the lateral and third ventricles. The head must be so placed in the fore-and-aft views as to throw the lateral and third ventricles above the frontal and ethmoid cells. Lastly, I am convinced that the Bucky diaphragm is essential for the detail required in the films.

I agreed to discuss this paper because, first, I thought I would learn something by so doing, and second, I wanted to tell of some of the difficulties we have encountered and to emphasize them by slides, hoping that Dr. Dandy and Dr. Baetjer could assist me over some of our troubles.

Dr. Dandy (closing discussion). I do not know that there is much more for me to say; after Dr. Baetjer's talk I feel very much embarrassed. You are all familiar with his great modesty concerning his own accomplishments.

Dr. Pancoast brought up the possibility that adhesions might be confused with tumor. There is no way to tell the character of the lesion. It can only be said that the lesion is located at a certain point, and in all probability can be found.

I have just gone over the statistics of tumors in the past year. This may be of interest, particularly in answer to Dr. Kennedy. I do not know precisely the number of localizations from the use of the *x*-ray alone—they were about 7 per cent in 1914—but they have increased considerably, for the *x*-rays are now much improved and our interpretations are superior. I should venture the guess that now at least 15 per cent of tumors can be localized by the *x*-ray alone. In a very high percentage of cases, compared to previous times, we can find actual shadows of calcification in the tumor. I think the localization of 50 per cent of tumors from neurological signs and symptoms, i.e., excluding the *x*-ray, is a pretty liberal estimate, and I doubt that it will come up to 50 per cent.

In 1914 we went over our cases, probably 70, and we could localize about 50 per cent with all means at our command. That included two or three and sometimes more operations.

During the last year we had 101 tumor cases; 4 of these died before operation (no injections of air). Of the 97 cases which we were able to study, 95 tumors were actually disclosed at operation. One of the 2 missed was a patient who was deeply unconscious at the time. The site of exploration was based upon an attack of Jacksonian epilepsy which was seen by his physician before the onset of coma. The other was a tumor in the brain stem which we made no effort to disclose. Of the 95 tumors found at operation, 6 required two operations, i.e., 89 were found at one operation and 6 in two operations. One of the 6 cases which required two operations was a case I saw with Dr. Kerr, a boy with hydrocephalus but with a small deformed ventricle on one side—a secondary feature possibly not related to the tumor. At the second operation a cerebellar tumor was found. Another one of the 6 cases was misleading because of decompression which was previously done and this decompression destroyed the value of the normal. The other 4 cases had hydrocephalus due to tumors of the pineal body or the hypophysis. Two of these had previously had air injected, and in two the air was injected after the operative failure. Of these 97 cases we used air in 35; in 62 we did not use air. It is, roughly, in 1 out of 3 cases that air has been necessary. There is one other feature which I have not mentioned. Twice I have operated for a tumor on the basis of air and the tumor has not been found. Both of those cases subsequently came to autopsy and neither had a brain tumor. One had a tumor in the spinal cord giving choked disc, headache and loss of eyesight. There are many conditions in the central nervous system still not understandable, and this is one of them. The other case was a boy who was blind, had headaches and choked disc. He had no tumor whatever. Our diagnosis of an occipital lobe tumor was largely by exclusion because the remainder of the ventricular system was normal and a tumor was considered a certainty. Had I verified the readings of the posterior horn, as should have been done, this part of the ventricle would doubtless have been shown to be normal at the second reading. It is very easy to misinterpret these roentgenograms, and, as Dr. Baetjer has told you, it requires a great deal of study. In reply to the view expressed by Dr. Kennedy that pineal tumors should be diagnosed by endocrine manifestations: tumors of the pineal body only at times give such symptoms. In only 1 of our 5 or 6 pineal tumors have any so-called glandular symptoms been manifested.

DERMATITIS ARTIFACTA SIMULATING ROENTGEN DERMATITIS

BY GEORGE M. MACKEE, M.D., AND GEORGE C. ANDREWS, M.D.

From the Department of Dermatology and Syphilology, College of Physicians and Surgeons
Columbia University

NEW YORK CITY

IN this article attention is called to the fact that self-inflicted injuries, lesions and eruptions, that may be classified under the general heading of dermatitis artifacta (malingering; dermatitis factitia; feigned eruptions; neurotic excoriations, etc.) may spontaneously or accidentally simulate roentgen or radium dermatitis; also that malingerers may intentionally and more or less successfully imitate a roentgen or radium dermatitis. In the latter instance the object is revenge, to avoid work, to collect insurance, to excite sympathy, interest, fear, etc.

The fact that self-inflicted eruptions may simulate roentgen or radium dermatitis to a degree that will deceive the inexperienced or the unwary, is of scientific interest and of medicolegal importance.

For obvious reasons, details such as would tend to identify the patient are omitted from the case reports contained herein.

MALINGERING VERSUS ROENTGEN DERMATITIS

Case Report. The patient, a woman, thirty-two years of age, was first seen by us on Nov. 18, 1920. She gave the following history of the evolution of the eruption for which she had been referred in consultation:

She had had a roentgenological examination of the left superior maxilla on August 22, 1920. A roentgenological examination of the antra was made on Sept. 1, 1920. On this latter date a second examination was made of the superior maxilla. Two weeks later (Sept. 15, 1920) the left cheek became inflamed, the inflammation being accompanied by a burning sensation. One week later (Sept. 22, 1920) an area of similar inflammation appeared on the back of the head and neck. A third area of inflammation developed on the back of the left wrist about a month later (Oct. 25, 1920).

When we first saw the patient (Nov. 18, 1920) she presented an irregularly square-shaped area of dermatitis on the dorsal surface of the left wrist. The dermatitis consisted of moderate erythema and slight exfoliation. The affected area was sharply outlined and about 2 in. square in size. On the left cheek there was an area of moderate erythema and slight exfoliation, about the size of the palm of a child's hand. The area was round, but it was not sharply outlined. On the back of the head there was a sharply outlined area of rather intense erythema with considerable exfoliation. It was round in shape and about the size of an adult hand. It was situated on the back of the neck, the upper part extending above the hair line. There was no defluvium capillorum.

It was noted that the degree of dermatitis (intensity of inflammation) varied considerably throughout the three areas. That is, scattered throughout each area were small areas of greater and lesser intensity.

The patient stated that an intense burning sensation was constantly present, but that at times the erythema became less and even disappeared in places only to return within a few days. She averred that the inflammation had been severe and associated with edema (skin very red, hot and swollen) but that there had been no ulceration or excoriation. It was ascertained that the inflammation in each area appeared suddenly and reached maximum intensity within twelve hours.

The patient had been seen by a number of physicians who accepted the diagnosis of roentgen dermatitis without discussing differential diagnosis. The roentgenologist who made the exposures was perplexed and perturbed but he, too, accepted the diagnosis of roentgen dermatitis and ascribed the unexpected result to idiosyncrasy.

We disagreed with the diagnosis on the following grounds:

1. The inflammation on the cheek appeared two weeks after the last exposure. That on the back of the head occurred three weeks after the exposure. The area on the wrist was first noticed six weeks after exposure. It is difficult to reconcile these findings with a knowledge of roentgen dermatitis. However, the possibility of "delayed reaction," variations in susceptibility of different parts of the body and variations in the quantity of radiation reaching the three areas, had to be considered.

2. The sudden appearance of the eruption and its rapid development are not characteristics of roentgen dermatitis.

3. The burning sensation was constantly present but the inflammation was alternately better and worse. This would not occur in roentgen dermatitis unless caused by the intermittent use of irritating topical remedies. The patient had been using ointments and lotions which were said to be of a soothing nature.

4. The contour of the lesions did not seem compatible with the known facts regarding the exposures. The patient was certain that she had held the film in the left side of the mouth with the left hand and that the back of the wrist was facing the tube. Such a position is awkward and unusual but it is possible. The roentgenologist could not recall how the patient held the film in position. Accepting the patient's statement, the wrist and cheek were exposed at the same time; yet the area on the wrist was sharply marginated and irregularly square in outline; while the area on the cheek was round with ill-defined margin.

5. The intensity of inflammation varied throughout the affected areas as already described. Such variation does not belong to the clinical picture of roentgen dermatitis.

6. The five points above enumerated strongly militate against a diagnosis of roentgen dermatitis. The sixth point, about to be elucidated, makes such diagnosis untenable. The patient had an eruption on the scalp which, if it represented a roentgen dermatitis, would be of a mild second degree. When first seen by us the eruption had been present on the scalp for four weeks, and a period of seven weeks had elapsed since the exposure. In spite of this there had been no defluvium. The scalp hair always falls out three weeks after a quantity of radiation sufficient for epilation has been administered. No dermatoroentgenologist will dispute the statement that a quantity of roentgen rays sufficient to produce a mild second-degree reaction is much more than enough to cause the hair to fall out.

At the consultation the possibility of malingering was suggested because:

1. The affection was not a roentgen dermatitis.

2. The eruption characteristics were not those of any known dermatosis.

3. The evidence pointed strongly to an attempt at the artificial production of an eruption that would simulate a roentgen dermatitis.

Subsequent History. The diagnosis of malingering was accepted with alacrity by the implicated roentgenologist and hesitatingly by some of the other physicians and dentists who were interested in the patient.

We saw the patient next on Jan. 15, 1921. The three areas were still erythematous and scaly. The hair had not fallen out. The affection was still intermittent in character. One of the physicians who was present at this consultation recalled that the patient had apparently feigned an illness several years previously, an illness that had been baffling at the time. Among other supposed symptoms, including feigned hemoptysis, she ran a temperature of 101° F., until it was discovered that the temperature was normal whenever it was taken by someone other than the patient. It is a very simple matter to elevate the mercury in a clinical thermometer by applying friction, with the fingers, to the bulb of the instrument. Also, at this consultation, the patient was told that another consultation would be held in two weeks, and that inasmuch as it was difficult to make a diagnosis and to outline a successful plan of treatment without seeing the eruption at its worst, it was hoped that maximum intensity would correspond with the appointed time for the next consultation. This is a very old and frequently successful psychological trick used by dermatologists in cases of feigned eruptions.

At the next consultation, Jan. 30, 1921, the picture was typical of malingering. Each area was intensely red with some edema. The intensity of inflammation was irregular, as though an acid had been applied to one small portion of skin at a time, instead of being applied to the entire area simultaneously. The wrist lesion presented one very characteristic feature. There was a streak of dermatitis one quarter of an inch in width, extending from the distal margin of the lesion over the dorsal surface of the hand for a little more than one inch. This indicated that a little too much of the caustic fluid (probably carbolic acid) had been applied and a drop had run down over the hand, producing this pathognomonic indication before the caustic action could be prevented by the addition of alcohol. The wrist lesion also showed two small areas of superficial ulceration. A plaster-of-Paris dressing was advised for the wrist, but the patient refused to use it. She was then made acquainted with the diagnosis and she indignantly denied complicity.

We last saw this patient on Feb. 6, 1923. The cheek was normal. The back of the neck showed irregularly distributed, faint erythema. The wrist area was bluish-red in color and it contained some cicatricial tissue. In this area were three lesions, a little smaller than a dime, consisting of dry, hard, black necrotic tissue, surrounded by considerable inflammation. They were of three months' duration. The patient stated that at various times the lesions consisted of blisters, suppurating ulcers, and simple inflammation (erythema and edema). At times there would be no lesions for several weeks. She still refused to permit the application of a sealed dressing and persistently denied complicity. Malingerers, however, usually deny guilt even when confronted with both circumstantial and direct evidence. There were no roentgen sequelae, such as atrophy, telangiectasia, pigmentation, depigmentation or alopecia on the wrist, cheek or back of the head and neck.

NEUROTIC EXCORIATIONS VERSUS ROENTGEN DERMATITIS

There is another entity falling under the general heading of dermatitis artifacta which, under unusual circumstances, may be confused with indolent ulcers caused by roentgen rays or radium. We refer to the condition known as neurotic excoriations (acarophobia; dermatothlasia; dug-out excoriations; acne urticata; excoriated acne of young girls, etc.).

In this affection the neurotic patient produces the lesion or lesions artificially by daily picking and squeezing the skin with the fingers or with an instrument such as a pair of epilating forceps. The affection differs from malingering in clinical manifestations and also because there is usually no intention of or attempt at deception. The patients will readily admit picking at the lesions and will often submit, for microscopical examination, tiny pieces of tissue which they have removed from a lesion. They are convinced that these tissue shreds are insects or foreign bodies, or in any event that they are the cause of the trouble and must be removed. Occasionally a patient will triumphantly submit a harmless and extraneous insect which has happened to be in or near the lesion. Not infrequently patients are unable to explain why they dig at the lesion; they seem to be unable to control the impulse or desire. Psychoanalysts explain that such habit is due to a misplaced or transferred sex impulse. It is very difficult to overcome or control this habit or mania. The lesion feels uncomfortable; the desire to manipulate becomes irresistible; the lesion feels more comfortable after the patient has worked at it for a while. The original cause of the picking is usually a milium body, a comedo, an inflammatory papule or, in fact, any slight elevation of the skin.

Naturally, the clinical manifestations are varied, and the affection may imitate such diseases as lupus, syphilis, epithelioma, tuberculide, acne, etc. There is one type of neurotic excoriation of special interest to roentgenologists, and that is the single indolent ulcer. This type may closely simulate the indolent ulcer that occasionally follows an acute third-degree roentgen or radium reaction.

We have in our files the histories of two patients which very nicely illustrate the clinical similarity between indolent ulcers produced by roentgen rays and those produced by artificial means. They were both under observation at the same time, so that the similarity was very striking.

One patient, a man, had had an epithelioma for which he received roentgen treatment. The treatment was followed by a third-degree roentgen dermatitis which later developed into an indolent ulcer. The ulcer was as large as a dime and situated on the left cheek close to the ear. It was crateriform (punched out) and presented a dry, glistening floor. The surrounding skin, having been carefully shielded, was clinically normal.

The other patient, a woman, presented an ulcer in the same situation, of the same size and of very similar appearance, but the history and cause were entirely different. The patient, fourteen months previously, had begun to pick at a tiny papule. She would spend an hour or two a day working at the lesion with a pair of forceps. The chronic, indolent ulcer was the result.

As a rule there is no difficulty in differentiating between the two conditions. In the case of roentgen ulcer there is a history of antecedent roentgen treatment and an antecedent acute roentgen dermatitis with severe pain. Also there is likely to be atrophy and telangiectasia around the ulcer. In the case of neurotic excoriation ulcer, there are the history of picking, the probability of multiple lesions, fantastic outlines, alteration in appearance from time to time, the absence of antecedent roentgen or radium treatment and of sequelae around the ulcer. Nevertheless, the two conditions can be so similar as to make a diagnosis by inspection somewhat hazardous. A history of previous roentgen treatment, an admission by the patient of picking at the ulcer, or a confusing, disputed or unreliable history, may make the diagnosis very difficult. It is well to keep these facts and possibilities in mind when giving medicolegal testimony. The next case report illustrates some of these diagnostic difficulties.

Case Report. The patient was a man, forty-four years of age, of nervous temperament and slightly neurotic type. He was referred to us on May 19, 1916, for the treatment of a large, indolent ulcer of two years' duration, situated on the lower part of the left cheek.

Past History. In 1912 the patient consulted a dermatologist for the diagnosis and treatment of an ulceronodular lesion over the left mandible which had been present for several months. The diagnosis was syphilis, but antisyphilitic treatment was not efficacious. In 1913 two dermatologists, working independently, each made a clinical diagnosis of epithelioma. Throughout 1914 the patient was given fractional roentgen treatment by a roentgenologist.

According to the patient's statement, the treated area became inflamed and painful, but the treatment was continued. Finally the pain became so severe that he refused further roentgen treatment. The ulceration then became more pronounced and, finally, indolent. It was the opinion of the patient that he suffered from a chronic roentgen dermatitis. The roentgenologist averred that the ulcer represented an epithelioma which had continued to evolve in spite of roentgen treatment; and that at no time during the course of treatment was there more than a first-degree roentgen reaction.

Personal Observations. When we first saw the patient in May, 1916, there was an indolent ulcer situated over the left mandible. It had remained almost unchanged for over a year. It was 3 in. in length, 2 in. in width and about 1/4 or 1/8 in. deep. The walls of the lesion were abrupt, which produced a punched-out or crateriform appearance. The floor of the ulcer was dry and shiny as, also, were the walls. There was no induration at the margins, nor were there any sequelae in the surrounding skin, such as atrophy or telangiectasia or permanent alopecia. The patient stated that the lesion had been exceedingly painful, but that now it was less so.

Our diagnosis was chronic roentgen dermatitis, and this diagnosis was confirmed by the members of the New York Dermatological Society. The roentgenologist vigorously opposed this diagnosis. It was his opinion that the lesion was either lupus or epithelioma and that it should receive further roentgen treatment. We could not seriously consider either of these diseases, but we were compelled to grant the possibility of the indolent ulcer type of neurotic excoriations for reasons that will soon be presented.

During the year that the patient was treated by us (1916 and 1917) there was little if any improvement in spite of ultraviolet rays, high-frequency current, strapping, and topical applications. After several months, the patient admitted that there was no more pain and that the lesion was sensitive only at intervals and then only at small points. These sensitive points were of a much brighter red than the remainder of the lesion and varied in location from time to time. These red, sensitive points, together with certain mannerisms and actions on the part of the patient, suggested the possibility of neurotic excoriation. Upon being accused and questioned, the patient exhibited a pocket mirror and a pair of thumb forceps. He admitted that he worked at the lesion several times daily and as long as an hour at one sitting. This had been going on for many months. The patient was obsessed with the idea that tiny pieces of gray tissue must be removed before healing could occur. He stated that if he abstained from manipulating the lesion for any length of time it became very uncomfortable and that considerable relief followed the use of the thumb forceps.

The history of the case was thus complicated, confusing and unreliable. In our opinion the lesion represented a roentgen dermatitis, the manipulation with the thumb forceps being a complicating factor. However, the possibility of the lesion having been caused by the patient had to be admitted. The patient ceased manipulating the lesion, or at least he claimed so, but there was no improvement. Several months later the entire lesion was excised, embedded in paraffin, cut serially, stained in various ways, and the serial sections were studied under the microscope. The pathological histology was that of roentgen dermatitis. The patient made an uneventful recovery and he has had no further trouble. He was last seen in August, 1920.

MALINGERING INTERFERING WITH A ROENTGENOLOGICAL RESULT

The case about to be described has no bearing on roentgen dermatitis, but it is of interest to roentgenologists as it illustrates how a malingerer may interfere with a therapeutic result. In this connection it may also be emphasized that patients with neurotic excoriations may modify the results of *x*-ray treatment. This is especially true in the types represented by Brocq's excoriated acne of young girls, Waelsch's urticaria necrotisans, and Kaposi's acne urticata. These affections may be mistaken for certain clinical types of acne vulgaris, seborrheic acne, acne varioliformis, tuberculide, lichen planus, and other dermatoses. If the patient continues to produce new lesions, or aids in their production, or interferes with the healing of a lesion, and this fact is not recognized by the roentgenologist, the result of roentgen therapy may be disappointing and confusing. On the other hand, when the habit is associated with definite elementary lesions such as comedones, acne pustules or papules, milia, etc., roentgen therapy may overcome or help to overcome the morbid habit by removing and preventing the formation of lesions that cause the desire to pick and dig at the skin. It is probable that many such cases are cured in this way without the artificial element being recognized.

Case Report. The patient was a woman, thirty-one years of age. She was normal physically. Temperamentally, she was phlegmatic, morose and neurotic. Appendectomy had been performed on July 17, 1919. Recovery was uneventful and the wound healed in the usual length of time. About two weeks after healing was complete, the skin became inflamed and the portion of the wound situated in the skin and subcutaneous tissue opened and suppurated. The wound was explored for foreign bodies, but none were found.

We saw the patient for the first time on Jan. 23, 1920. She was still in the hospital and she spent most of the time in bed. Examination revealed a long, narrow, shallow, rather insensitive ulcer on the right side of the abdomen. It was $3\frac{1}{2}$ in. long, $\frac{1}{2}$ in. wide, and about $\frac{1}{8}$ to $\frac{1}{4}$ in. deep. There was a slight, purulent discharge from one end of the wound. The remainder of the ulcer was dry, and presented anemic-looking granulation tissue. The tissue in and near the wound was markedly infiltrated; in other words, the wound was keloidal and it was supposed that the development and presence of the keloid had prevented the wound from healing.

Five intensive roentgen treatments, at monthly intervals, effected complete involution of the keloidal infiltration. The wound was now soft, the granulations appeared healthy, but it did not cicatrize. Ultraviolet radiation and various topical remedies were tried with indifferent results. At times the wound would almost heal, only to break down again. Finally, the curious behavior of the wound and the patient's temperamental defects directed attention to the possibility of malingering: excoriations and scratch marks were noticed in the normal skin near the edge of the wound; at times the granulations were dry and inactive; at other times they were red and active; occasionally the floor of the ulcer looked as though it had been rubbed and scratched; at the menstrual periods, regardless of the condition of the granulation tissue, the wound, surrounding skin and gauze dressing, were stained a brownish red.

From Aug. 1, 1920, to Sept. 20, 1920, experiments with sealed dressings were conducted. If the dressing remained sealed the wound healed. Usually the dressing was partially or entirely removed by the patient. After healing, scratch marks could be detected in the scar before the wound opened. The patient persistently denied the accusation of malingering. Surgeons occasionally encounter cases of this kind, but the experience is rather unique in roentgenology.

THE INFLUENCE OF X-RAY THERAPY ON BENIGN AND MALIGNANT GROWTHS DEPENDENT UPON AN APPARENT VALID DISTINCTION BETWEEN THEM*

BY GOTTWALD SCHWARZ, M.D.

Associate Professor and Director of the Roentgen Institute of the Kaiserin Elizabeth Hospital,
Vienna; Honorary Member of the American Roentgen Ray Society

VIENNA, AUSTRIA

IN THE following communication I beg you to count not so much on hearing unknown facts as seeing set forth well-known facts in a new conception, which may have value both for the theoretical problems of malignant growths, and as well, for the much-fought-over question of practical *x*-ray therapy.

Let us first consider the action of *x*-ray energy upon the normal growing cell-groups of the human body, and take as an example an epithelial tissue, the hair. A definite dose of *x*-ray causes a stoppage of growth of the matrix cells. The hair curls up and falls out. The arrest of growth lasts for from several weeks up to months. After this time the uninfluenced remaining matrix cells begin a regeneration of the hair root. The proliferative activity increases more and more and a new hair is formed. There results, so to speak, a recurrence.

If we now remove this re-grown hair again by means of *x*-ray, we find that the application of the same or even a somewhat lesser dose than the first one is sufficient to produce a stoppage of growth and epilation. For a re-epilation of the re-grown hair an increase of the dose is not necessary; rather the contrary is true. Repeated epilation leads most certainly to a definite destruction of the hair root.

A similar relationship exists for normal and benign growths of mesodermal tissue. Let us take, for instance, from the connective tissue group growths, the keloid; we find here also under repeated *x*-raying no decrease, but rather an augmentation in radiosensitiveness. One can get analogous results in the case of all normal or benign hyperplastic tissues, whether they are of ectodermal or mesodermal origin, so that we can lay down the following rule: *Normal benign growing tissue shows toward repeated x-radiation a uniform or increased sensitiveness.*

---

* Read at the GERMAN ROENTGEN RAY CONGRESS, Munich, 1923.

Fundamentally different is the case as to the effect of *x*-rays upon the growth of malignant blastomas. It is a phenomenon well known to all *x*-ray therapeutists that both carcinoma and sarcoma, in event of a recurrence (with the exception that I do not refer to the definite late recurrence appearing years after the first appearance) become gradually more refractory to the influence of *x*-rays. This phase is especially emphasized by Rieder in his textbook on radiotherapy; and Jüngling and Kästle have mentioned at a recent *x*-ray meeting in their recapitulation of cases such cellular adaptability or self-immunizing phenomenon to *x*-ray action. I have in mind the striking example of lymphosarcoma in which case after the first exposure to *x*-rays the tumor literally melts away; then after the first recurrence it becomes less sensitive, and finally, with the latest recurrences, it no longer reacts even to the largest doses of *x*-rays. And yet, not only in the case of malignant lymphomas, but in all recurrent sarcomas and carcinomas, one invariably observes this immunization against *x*-ray influence; so that we formulate this rule: *Malignant recurrent anaplastic blastomas exhibit a decreasing sensitiveness to the influence of x-radiation.*

Now if we contrast this diametrically opposite behavior, namely, the unaltered roentgen-sensitiveness of benign growths and the decreasing roentgen-sensitiveness of malignant tumors, then we must finally acknowledge that here lies a fundamental difference, which relates to the principal peculiarities of malignant blastomas in their reaction to *x*-rays. While the benign cell complex, an integral part of the organism altruistic in character, fully transmits to its descendants the property of reacting to *x*-ray damage by an arrest of growth, on the contrary, with malignant blastomas, there is found an increasing resistance to *x*-radiation.

P. S. Meyer has lately reported (*Klin. Wchnschr.*, April, 1923) on the self-immunizing phenomena of the bacillus prodigiosus to *x*-rays. I believe it to be correct to assert that the adaptability of the malignant blastomas to *x*-rays is analogous in character to that observed by Meyer in his work with bacillus prodigiosus colonies. One may see from this example how, by way of cell metamorphosis of the normal into malignant cells, the latter has literally assumed the character of an autonomous, parasitic growth.

Now, if we inquire further as to whether this phenomenon also has, as a basis, a recognizable histological change, we must mention the researches of Aschoff, who, in common with Krönig and Gauss (*München. med. Wchnschr.*, 1913) have seen in the left-over carcinomatous remnants, this metaplasia as one of greater maturity; as, for example, the transformation of nonhorny into horny portiocarcinoma. Differing completely from these findings of Aschoff are those of Ludvig Adler (*Zentralbl. f. Gynec.*, Vienna, 1916) who stated positively that a ripening of the tumors during irradiation is not at all observable and that in all cases where, after exposure to *x*-rays, a recurrence appears, the recurrence has constantly proven itself less differentiated than the initial favorably influenced primary tumor.

Without wishing to bring into this discussion these controversial questions of greater or lesser maturity, it seems to me very important to emphasize the fact obtained from both of the works quoted that morphological changes do occur in the recurrence of mixed-cell type blastoma after periodical *x*-raying, changes which undoubtedly are connected with this particular self-immunizing phenomenon.

In conclusion I wish to present my own conception of the problem which we have before us. While benign cells of a like mother tissue, essentially bound together, are submitted to the same laws of growth, they form, so to speak, a similar cell race; in the other case (malignant growth) one must consider the recent findings of tumor research with experimental tar carcinoma of the mouse and *x*-ray carcinoma which are resulting malignant blastomas, through the gradual oft-repeated breeding from benign hyperplasia.

In my judgment we must agree that in malignant neoplasms, both benign and malignant elements exist in numerous modifications and combinations, all of which exhibit varying degrees of different *x*-ray sensitiveness.

With the *x*-ray attack acting upon the malignant blastoma two sequences are possible: (*a*) The entire cell group is destroyed, which results in a permanent disappearance or complete healing. (*b*) The *x*-ray sensitive groups are destroyed while the less sensitive groups are only slightly checked or remain uninjured, which is the case of temporary healing or only slight recovery.

If we now analyze the second possibility (which alone is of interest to us) it will be clear that the recurrent tumor will be rebuilt from those cell groups which, through their low *x*-ray sensitiveness, will thereby be protected from permanent destruction.

Thus considered one sees why the recurrent tumor *must* necessarily exhibit a lesser *x*-ray sensitiveness. By elimination of the *x*-ray sensitive groups we have selectively cultivated the lesser sensitive groups. It is my opinion that there is absolutely no doubt but that with all malignant blastomas, the elements of which cannot be completely destroyed by *x*-rays without leaving resistant remnants, we bring about, by means of the *x*-rays sooner or later an evident increase of resistance of the malignancy against the arresting effect of the *x*-rays.

The question immediately arises as to whether this heightening of the degree of malignancy is exclusively an *x*-ray specific or whether it is general. Clinical observations make it probable that the latter is the rule. By no means, however, are we able *a priori* to set aside the possibility that, through such selective pure culture of the tumor cells less capable of being checked in growth, there follows a general heightening of the malignancy, in the sense that the blastoma becomes nonsensitive to *x*-ray influence through repeated exposures and eventually is more refractory to the retarding influences naturally existing in the organism. Naturally we dare not withhold this self-evident possibility in considering the influence of the *x*-rays. For even in the unfavorable cases we succeed in obtaining a temporary lessening of the endurance of the tumor, which improvement cannot be foreseen.

The time at our disposal is too short to discuss the subject in all its possibilities which present themselves in practice, in the conception as here set forth. I wish this communication to direct your attention to this proposition: that we are dealing with fundamentally different biological situations in the *x*-ray reaction of benign tumors and in the *x*-ray reaction of malignant blastomas. Through this it is understandable that while advancement of growth is not demonstrable after *x*-raying in normal tissues (at least successfully until now); in malignant tumors such an acceleration of growth is possible in the sense of a heightening of the malignancy produced by *x*-rays through selective breeding.

RECENT DEVELOPMENTS IN PROTECTIVE METHODS AND APPLIANCES AS USED IN RADIUM THERAPY

BY CURTIS F. BURNAM, M.D., AND GRANT E. WARD, M.D.

BALTIMORE, MARYLAND

In using radium, especially in large quantities, one is steadily confronted with the problem of protection—protection both of workers and patient. Protection of the workers has been described in an article by Dr. Howard A. Kelly on "The Care of Radium in the Hospital" (*Mod. Hosp.*, May, 1922, xviii, No. 5). We propose to mention here a few important appliances developed since the above publication.

The criteria of an efficient therapy apparatus are (1) It must prevent all radiation of the patient except at the site of disease. Protection against general radiation is essential to guard against a possible anemia from repeated heavy doses over blood-forming organs. A satisfactory apparatus must also protect such internal secretion glands as adrenals and thyroid, as well as ovaries and testicles. Exceptions to this rule are the radiation of large fibroids, large spleens and massive tumors, where any possible disturbances arising from scattered rays affecting other parts of the body are of less importance than an incomplete radiation. (2) The perfect apparatus must permit the cross-firing of deep tumors without allowing the over-lapping of the rays to irritate the skin. (3) It must be capable of perfect fixation when in position. If the apparatus is easily dislodged from its correct position during a treatment there is either damage to the normal part or an inadequate treatment of the disease. (4) It must also be comfortable for the patient, as the treatments sometimes last for several hours. (5) It must be so constructed that it can be adjusted easily and accurately without the least possible exposure to the trained operator. In most of our work the doctor in charge "sets up" the appliance and leaves the room while the nurse, whose duty in the radium department covers a shorter period of time, places the emanation in the applicator (see article cited above). (6) As far as possible it must lessen the exposure of the nurses who handle the emanation.

Guided by these criteria we shall now discuss briefly the various applicators and their relative advantages.

For completeness' sake we mention first the older principle of the plain package, used without lead filtration wherever a general radiation is desired, as in large spleens and fibroid tumors. The package is of felt of a thickness equal to the chosen distance of filtration; is about 2 × 3 inches at the end resting on the skin and is strapped to the bottom of a wooden box with a hinged cover. The prepared package is held in position by long adhesive straps running out to sandbags at the side of the patient. The operator now leaves the room and the nurse enters, carrying the tubes of radium emanation with a long forceps as far as possible from her body, and drops them into the wooden box. As stated, the operator himself rarely handles the emanation, while the nurses charged with this duty are changed so frequently that their total exposure is negligible. This is our procedure in "setting up" all our treatments, with the exception of those special ones which require the more experienced hand in the actual application.

In most cases, lead protection to all parties involved is advisable. Our former method of securing this was a flat or curved piece of lead for the filter, with an opening for the passage of the rays of the size and shape of the lesion in question; the radium was then laid in place on the distal side of the lead, as shown in Figure 1, Diags. A, B and C. We see at once that there are several possible adjustments of a lead filter lying between the emanation and the patient; three positions are shown in Diags. A, B and C. In any of these situations there is of necessity a great scattering of rays (*s*) which travel in all directions. To limit this distribution one of us (G. E. Ward) devised a cylinder whose operating principle is shown in Figure 1, Diag. D; with a longitudinal, sectional view in Diag. E. In such an arrangement with a wall of

1 in. of lead, the scattering is reduced to below 20 per cent of its original intensity, while the rays traveling directly toward the lesion (*d*) remain unaffected and unabsorbed. The filtration of the oblique rays adjacent to the circle (*d*) the area under treatment, is through 2 to 3 in. of lead. In actual use this radium emanation carrier holds many emanation tubes of varying strength. In order to assure a more uniform radiation of the area treated, the strong tubes are placed in the central pockets, the weaker ones next, and the weakest in the marginal pockets. The carrier is rotated during the treatment by the nurse by turning its handle clockwise, so that at the end of the treatment it has completed the circumference of the cylinder. Such an applicator meets all the criteria of efficiency.

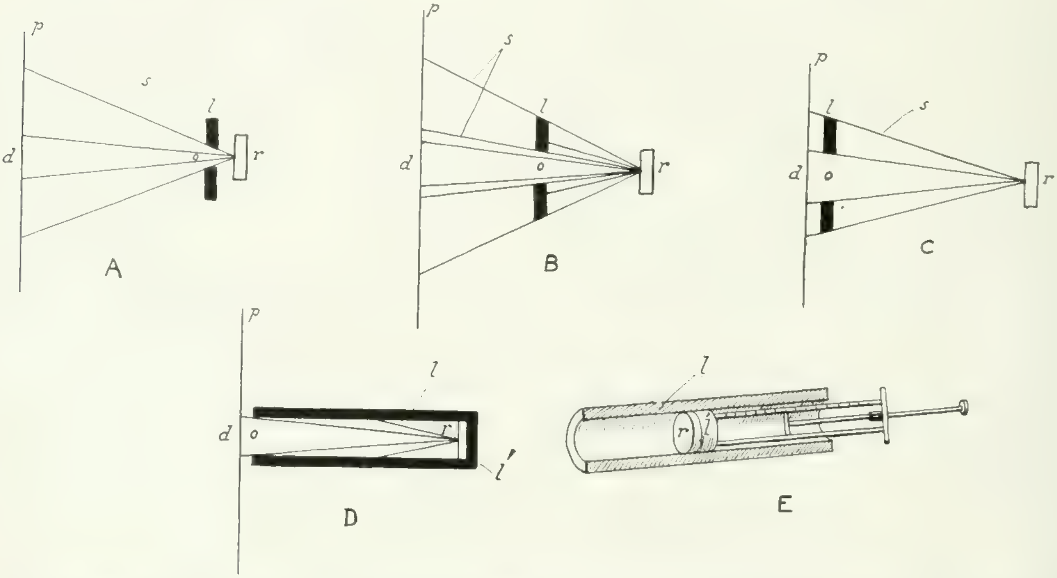


Fig. 1. Diagram of the principle of plain lead filters as compared with the Ward cylinder. The lettering in all diagrams is as follows: (*r*) box containing radium emanation; (*l*) lead filter with portal (*o*); (*p*) skin of patient; (*s*) scattered rays. Diagram A, lead filter (*l*) next to the radium emanation. Diagram B, lead filter (*l*) midway between radium emanation and patient. Diagram C, lead filter next to the skin. Diagram D illustrates how the rays are absorbed by the walls of the cylinder, only those destined to reach the lesion being unobstructed; (*l*) represents 1 in. of lead in the cover of the emanation carrier (*r*) which affords protection of the nurse's hand while she is inserting or removing it from the cylinder. Diagram E, a longitudinal sectional view of the cylinder containing emanation carrier. The latter is equipped with handle to facilitate in manipulation. The length of the handle and the carrier together correspond to the length of the cylinder. A scale is so arranged on the handle that as the carrier is moved in the cylinder the number of inches read at the distal end indicates the distance of filtration.

Figure 2 shows a cylinder in place during the treatment of a parotid tumor; note protection of the eye, ear, shoulder and neck. With this instrument we focus accurately upon the disease without jarring the emanation out of place; it is also comfortable, as there is no pressure against the skin. It is easily adjusted so that the operator when leaving the room is confident there can be no mistake in inserting the emanation. By means of the extra lead in the cover of the carrier (see *l*, Diag. D, Fig. 1) the nurse's hands are protected. General radiation of the body is limited and by mapping out the various areas over a large tumor and focusing them at several angles, cross-firing is secured without irritating the skin. Whether there is an actual increase in the dosage, due to reflection of the gamma rays from the lead, remains to be determined. Detailed measurements of the width and intensity of the cone of rays at various depths beneath the skin will furnish desirable data as to the actual intensity of treatments at given depths. We believe that the diverging cone of radium rays permits of more accurate focusing than the parallel and therefore narrower beams of rays from the Coolidge *x*-ray tube, for the deeper the cone of the radium rays penetrates, the wider it grows and the more certain it is to cover all the disease. Further studies will be issued as completed.

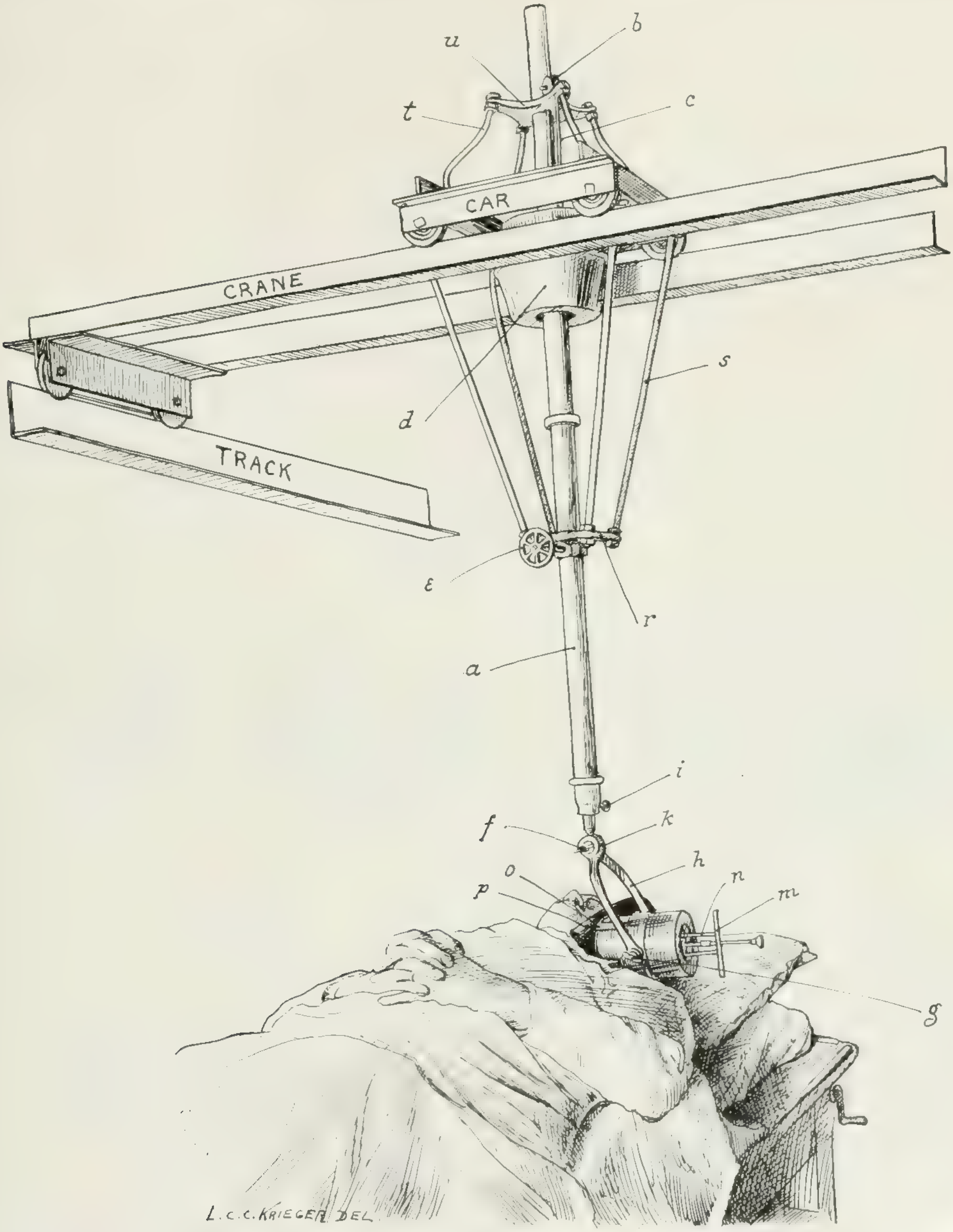


Fig. 2. Suspension apparatus and cylinder "set up" as in the treatment of a parotid tumor; (*a*) shaft; (*b*) pulley carrying cable (*c*) which suspends shaft and counterbalances weight (*d*); (*e*) safety hand-screw; (*f*, *g* and *i*) thumbscrews for adjusting cylinder; (*k*) cogs preventing bail (*b*) from slipping; (*n*) scale on handle (*m*) of radium carrier; (*o*) aluminum filter cap; (*p*) sheet rubber filter; (*s* and *t*) braces ending in brass plates (*u* and *r*) which prevent any swaying of shaft.

Following the introduction of our lead cylinders we noticed the striking fact that the same dosage we had been using in like cases with the plain package now caused a marked erythema in some 80 per cent, sometimes even amounting to blistering, an obviously undesirable reaction. The irritation was not like an overdose of gamma rays, but came from two or three days to as late as five weeks after the treatment and lasted from a few days to six weeks. (This has been a matter of careful statistical research.) We thought at first that it was due to "K radiations" from the lead (that is to say, specific for lead) or possibly to some excited secondary beta radiations. To obviate this we first tried placing two to four layers of thin rubber between the orifice of the cylinder and the skin, and failed; 2 mm. of aluminum were then added to the rubber, and since that time we have had no more of the irritation. The aluminum absorbs the secondary rays from the lead and the rubber the secondary rays from the aluminum and we are quit of them. These aluminum protectors are thin discs 1 mm. in thickness, cut to fit the size and shape of the end of each cylinder applicator nearest the skin. The one at D, Figure 4, is for the 2-in. cylinder, and the one at C, Figure 3, is curved to fit the end of the cylinder B of the same figure.

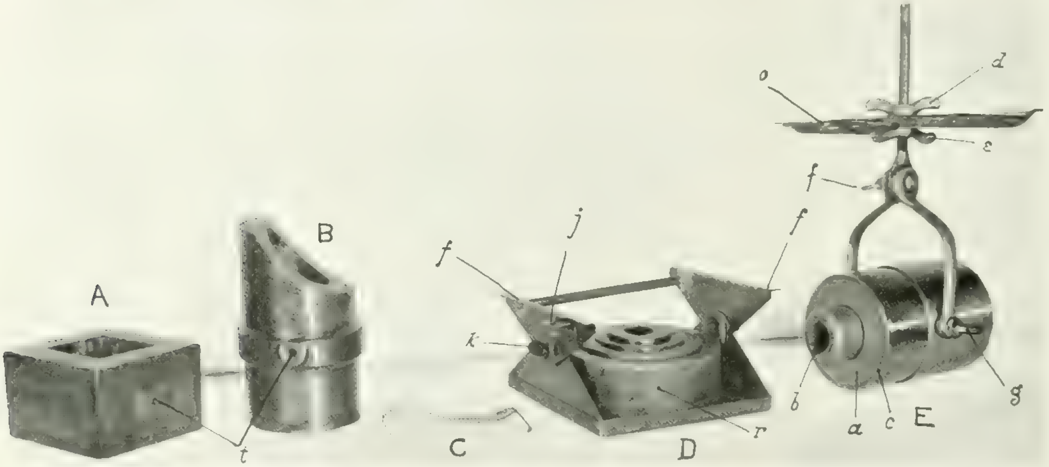


Fig. 3. A, "square cylinder." The advantage here is that in treating adjacent areas the square portals leave no portion of the tumors unradiated: (*t*) holes for thumbscrews which hold cylinder in suspension apparatus. B, a cylinder with proximal end cut to fit curved surface of the skull. This was used in treating an inoperable brain tumor from five angles without overlapping. C, aluminum filter; cap curved to fit cylinder B. D, set of treatment rings shown in the car which carries them and which runs on the track of the portable suspension table shown in Figure 6; (*r*) lead rings; (*f*) flanges to fit tracks; (*j*) thumbscrew which tightens against track and serves as brake on the car; (*k*) thumbscrew adjusting angle of the car and rings with the skin. E, 2-in. cylinder with adjusting apparatus as used with the portable suspension table shown in Figure 6. In the figure a longer cylinder (*b*) with a 1-in. portal is seen projecting from the 2-in. portal of the larger and shorter cylinder. Such a device is used in treating glands situated in difficult places, as beneath the jaw, etc.; (*a*) wall of 2-in. cylinder made of 1 in. of lead. (*c*) $\frac{1}{8}$ in. brass reinforcing lead; (*f* and *g*) thumbscrews for adjusting cylinder to any angle with the skin; (*o*) car for portable suspension table seen in Figure 6; (*d* and *e*) wing nuts for adjusting height of cylinder.

At D, Figure 3, are shown several circular applicators of a different type; these are used when it is not necessary to guard so carefully against scattering, but when some lead protection is advisable, and also in treating with the portable suspension table (described later). This set of applicators consists of a series of four rings, each 2 in. high and fitting one inside the other as shown. In the figure one is raised above another to demonstrate the construction. The portals are 1, 2, 3 and 4 in. in diameter. In setting up the apparatus the desired portal is chosen and the box containing the radium emanation is placed on an adhesive tape strapped across the top of the portal. The rings are shown in the car made to carry them (see description of portable suspension table, Fig. 6).

In using such heavy applicators, the question immediately arises as to the mechanism of handling and support. Several ideas were suggested, but the one which seemed the most efficient and permitted of all movements, so that focusing in any direction and on any tumor would be easy, was the suspension apparatus shown in Figure 2. (We owe much to the cooperation of Dr. Fred West of our staff and to Messrs. Nicholson and Johnson, mechanics, for help in devising the suspension apparatus, as well as the treatment table and mechanical achieve-

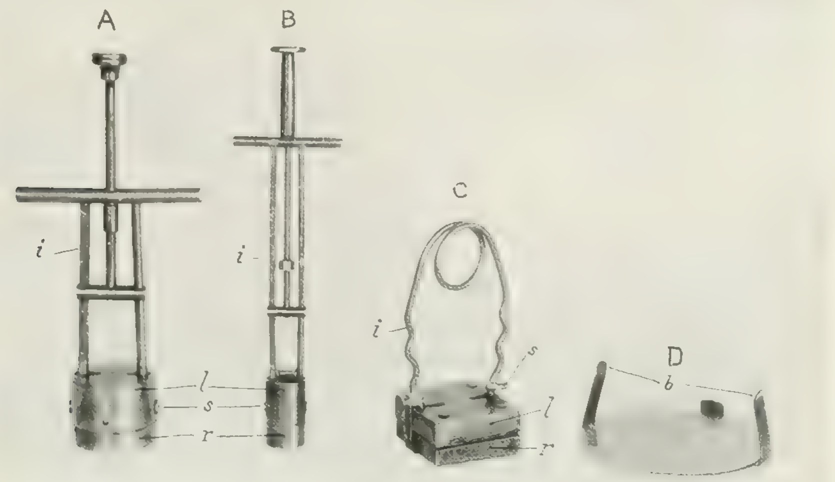


Fig. 4. A, emanation carrier for 2-in. cylinder; B, emanation carrier for 1-in. cylinder; C, emanation carrier for "square cylinder"; (*l*) 1 in. of lead in cover of carrier (in square carrier C it is ½ in. in thickness); (*r*) emanation container made of hard rubber reinforced with brass (no brass on bottom so that filtration is only through a thin layer of rubber); (*s*) brass stubs so arranged that movements of the cross-bar of the handle upwards force them against the inner wall of the cylinder, thus fixing the carrier at the desired point. In C the spring of the handle serves to force stubs against wall of the cylinder; (*i*) scale in inches indicating distance of radium emanation from mouth of the cylinder; D, aluminum filter-cap for 2-in. cylinder. This slips easily over proximal end of the cylinder and is held in place by brass springs (*b*) at the sides.

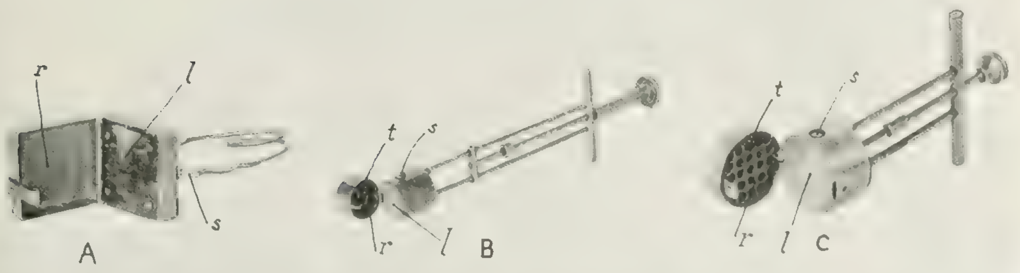


Fig. 5. B and C, emanation carriers for the 1-in. and 2-in. cylinders respectively; open to show pockets (*t*) for emanation tubes (*s*, *l* and *r*) as in Figure A, emanation carrier for square cylinder, open to show plain brass box (*r*) without separate holes for each tube. This is used when our emanation tubes are of variable size, as when several special-size tubes are made for a specific treatment and later used in the composite package of emanation.

ments of the cylinder. Their skilled workmanship has made these appliances possible.)

The suspension apparatus is briefly as follows: A firm track of 4-in. angle iron carrying a fairly long crane is built in the room. The crane supports a car 18 in. square and made of 2-in. angle iron. The cylinders are suspended from the car by means of a shaft (*a*) of 1½-in. pipe swung on two cables (*c*) running over two pulleys (*b*) at the top and fastened to a weight (*d*) which counter-balances the cylinder. In this manner a vertical movement of 22 in. may be given to the cylinder without necessitating actual lifting. A safety handscrew (*e*) is placed in the lower end of the car, which, when tight, prevents any vertical movement of the shaft, thereby assuring a firm position when set up and at the same time guarding against accident if the cable should break. A series of thumb-screws allows all movements necessary to focus at any point on the body. With this suspension all weight is taken off the patient, who is thus able to lie comfortably for several hours. It is often impossible or inexpedient to bring a patient to the treatment room. Accordingly, a portable suspension table (referred to above) is used, the patient remaining in his own bed. This apparatus, illustrated in Figure 6, carried any type of cylinder as well as the concentric rings. In the illustration the largest ring and a 2-in. cylinder are shown in place, although of course, only one is used at a time when treating.

For further protection to workers, and for further facilitating giving various treatments, C. F. Burnam devised the treatment table shown in Figure 7, made of wood and measuring 6 ft., 8 in. in length, and 2 ft., 11 in. in width, and standing 2 ft., 8 in. high. The top is smooth except for a ½-in. ridge around the edge to hold the mattress on. The protective feature of this table consists of a lead block 1 in. thick and 18 in. square beneath the top of the table and carried by a car running on track and crane. By means of rope, pulleys and crank, and handles projecting down from the car, as indicated in the figure, and reproduced in the cut, this lead block may be placed directly in line of fire of the rays from the charge of radium emanation in the cylinder, thereby absorbing the

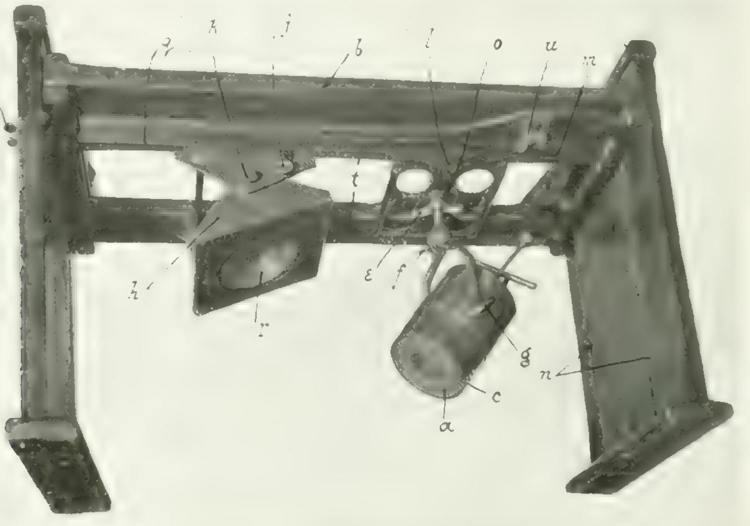


Fig. 6. Portable suspension table; (*n*) two vertical slots in end of the table through which pass bolts from adjustable top (*b*) allowing it to be fixed at any desired height by tightening thumbscrew (*p*); (*t*) track; (*b* and *o*) cars. One track is pivoted at (*q*), the end (*m*) being movable so that, by spreading, the cars may be taken off or put on; (*u*) thumbscrew for tightening movable end of track. (*l*) brake for car (*o*) thumbscrew removed. Other lettering as in D and E, Figure 3.

rays and safeguarding those in the room below. This may seem unnecessary at first, but when we recall the sad experience of the fogging of seventy-five dollars' worth of photographic plates in a room obliquely below the one in which radium treatments were given, the caution is clearly justified. A glance at the figure shows a two-piece mattress, the upper and larger part measuring 2 by 4 ft. and the lower and smaller one 2 ft. square, the purpose being to facilitate cervical, intrauterine, rectal and other treatments requiring a change from the perineal to the dorsal posture. In such cases the lower mattress is removed and the upper one brought to the foot of the table. The patient is put in the perineal position, and the treatment applied, with or without anesthesia, after which the upper mattress is pulled back into place, bringing the patient completely on the table. The lower mattress is now put under the legs, the handle of the radium applicator being strapped securely to sandbags. In this manner lifting and tugging at the patient with the consequent danger of dislodging the radium applicator are avoided and the treatment is affected quietly and easily.

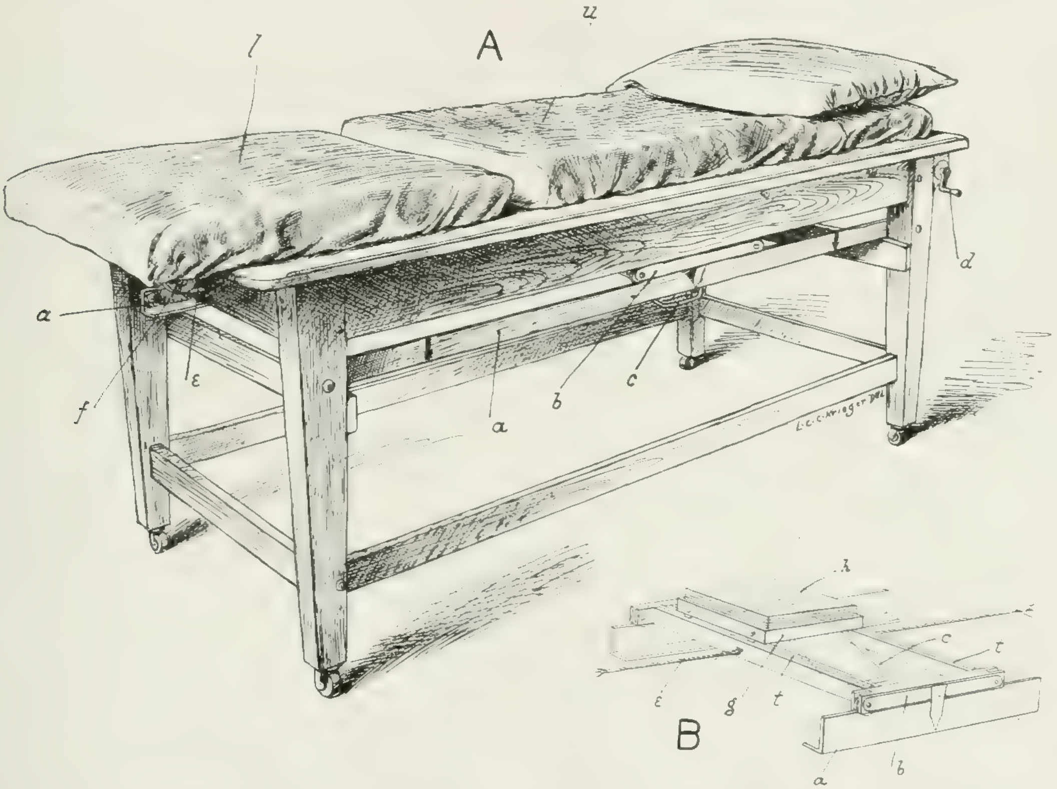


Fig. 7. A, Burnam treatment table. (*a*) track of 2-in. angle iron; (*b*) end of crane with arrow indicating center; (*c*) handle for moving car; (*d*, *e* and *f*) crank, rope and pulley respectively, used for moving crane. (*l* and *u*) lower and upper mattresses respectively, separated to show construction. B, Insert showing crane (*b*) and car (*g*) carrying 1-in. lead block (*b*) 18 in. square; (*t*) tracks on crane for car (*g*); (*c*, *e* and *a*) as in A.

SUMMARY

1. Great emphasis must be placed on thorough protection in using radium in therapeutics. The following essential features must be borne in mind in choosing efficient apparatus for heavy treatments.

(*a*) It must prevent as far as possible all radiation of the patient except at the site of the disease.

(*b*) It must permit of cross-firing at deep tumors without over-lapping. An example of this may be seen in the treatment of rectal carcinoma where, by the use of these cylinders, we frequently give 10 gm.

hours radiation at a 3-in. distance over six areas. These areas are chosen over sacrum, perineum and abdomen. Taking the distance from the skin to the growth as being on an average of 2½ in. we see that the total dose would be 60 gm. hours at 5 in. distance, or more than 2 gm. hours direct, and at the same time we are radiating any metastatic growth in the pelvis.

(*c*) It must be capable of being made absolutely immobile after it is once "set up," so that the operator will be confident that when he leaves the room the nurse can easily place the charge without dislodging the apparatus.

(*d*) It must be easy and accurate of manipulation without exposure of the operator.

(*e*) It must be comfortable for the patient.

(*f*) It must limit as far as possible exposure to nurses handling the emanation.

These criteria we claim are met in the cylinders and the suspension apparatus above described.

2. We wish to encourage the use of aluminum and rubber as efficient filters to absorb soft, secondary radiation when using lead protection in radium therapy. (In treating growths in the mouth, vagina and other cavities, the gauze in which the lead filters are wrapped absorbs the soft secondary rays from the lead.)

3. With the use of the treatment table we can greatly facilitate our heavy external treatments and our intrauterine and other treatments requiring a change of posture from the perineal to the dorsal, at the same time affording an added protection to those in the rooms below the one in which the treatment is being given.

THE RESISTANCE OF THE THYROID GLAND TO THE ACTION OF RADIUM RAYS. THE RESULTS OF EXPERIMENTAL IMPLANTATION OF RADIUM NEEDLES IN THE THYROID OF DOGS*

BY J. O. BOWER, M.D., F.A.C.S., AND J. H. CLARK, M.D.

Department of Surgical Research, Graduate School, University of Pennsylvania

PHILADELPHIA, PENNSYLVANIA

THE following work was undertaken to determine the effect of radium rays on normal thyroid tissue. The results, we feel, will be of interest to the radiologist, for they seem to emphasize that the type of tissue radiated is of equal importance to the dosage.

Abbe[1] in 1904, reported a case of exophthalmic goiter in which a capsule containing 10 cgm. of Curie radium (300,000 activity) was inserted in the hypertrophied middle lobe and allowed to remain *in situ* for twenty-four hours. Four months later, the patient felt subjectively well, although a slight tachycardia was still present. The circumference of the neck had diminished 1½ in. and the thyroid seemed to be about ⅙ its former size. Burrows[2] in 1918, reported 79 cases of exophthalmic goiter treated by radium; 2 with implantations, 75 with surface applications. One with implantation of tubes did not return for re-examination, but the other showed considerable diminution in the size of the gland and improvement in symptoms. Aikins[3] in 1916, had treated 45 cases with surface applications and in 1920,[4] reported a total of 100 so treated. Clagett[5] in 1920, reported 31 cases in which surface applications of radium had been used. Terry[6] in 1921, implanted emanation tubes in 11 cases and in 1922,[7] reported 22 additional ones.

While the reports from these authors were in all instances favorable, the technique of application and the dosage varied very markedly. Abbe[1] implanted 100 mg. of unscreened radium for twenty-four hours (2,400 mg. hrs.). Aikins[4] screened the beta rays and employed a primary

---

* Preliminary report read before the Section of Experimental Surgery, American College of Surgeons, Philadelphia, Pa., October, 1921.

treatment of 150–360 mg. hrs., and subsequent treatments of 50–150 mg. hrs. Clagett[5] obtained symptomatic cure using 50 mg. hrs. of radium screened by silver, brass and rubber. Later he applied 100 mg. of radium filtered through lead, rubber and platinum for from 6–12 hrs. (600–1200 mg. hrs.). With the exception of Terry[7] none of these authors reported the histologic changes in the thyroid following radiation, nor have we found any reference in the literature to the changes produced by radium in the normal thyroid.

Dogs were used in the experiments because of the size of the thyroid glands and because histologically they are almost identical to those in man. Implantation of radium needles was chosen as the best method of determining the changes produced, since the effects of different dosages could be accurately noted, and there would be no chance of the needles slipping, which might occur if surface applications were employed. Needles containing 12.5 mg. of radium were used throughout the experiments. A steel needle, of the same size as that containing the radium, was used as a control. Both were threaded with silk and sterilized by placing in 95 per cent alcohol for twenty minutes. The dogs were etherized, the necks shaved and painted with tincture of iodine. The glands, lying one on either side of the trachea, just below the thyroid cartilage, were exposed through a mid-line incision and separation of the neck muscles. The thyroid was freed from the surrounding loose areolar tissue by blunt dissection, care being taken not to injure the blood supply entering the gland at the inferior pole. The glands were very resistant and tough, so a cataract knife was used as an obturator, as this produced less trauma than the attempt at forceful introduction of the needle alone. Both radium and control needles were inserted into the thyroid at the inferior pole as near the center as possible; the glands were then allowed to slip back in place and the silk strings brought to the lower end of the incision and coiled up between the fascia and the skin. Both fascia and skin were closed with interrupted silk sutures. After varying periods of time, the dogs were again anesthetized, a few of the sutures removed and the needles drawn out by gentle traction. The wounds were closed without drainage. With the exception of one stitch abscess in Dog No. 2, all wounds healed by primary union. The animals, with the exception of two, showed no ill effects from the operation or from the loss of thyroid tissue, which was small in all cases. Dog No. 7, operated on in the heat of midsummer, was extremely sick and prostrated, although the wound was clean. In Dog No. 13, the radiated gland had diminished to one-quarter the size of the control gland, while the dog had increased in weight and had become less active. They were killed at the expiration of a specified time (Chart I). The glands were weighed, hardened in salt solution containing 4 per cent formalin, sectioned and stained by the routine method (haemotoxylin and eosin) and Mallory's connective tissue stain.

In all, 15 dogs were employed. The needles remained in the thyroid from 2 to 13½ hours. The glands were removed at the end of 7, 10, 14, 21, 28, 68, 73, 75, 84, and 210 days. The results can be briefly summarized as follows:

RESULTS

The portion of the gland affected by the radium showed grossly as a yellowish area surrounded by a narrow reddish band. The size varied with the length of time the radium acted, but not in direct proportion. In Dog No. 1, 25 mg. hrs. produced a lesion 1 × 2 mm. in diameter; Dog No. 3, following 50 mg. hrs., showed an area of destruction 2 × 4 mm., while in Dog No. 5, an exposure of 112 mg. hrs. destroyed only an area 4 × 3 mm. in diameter.

The destructive action of the radium persisted to about the beginning of the third week, with an increase in the weight of the gland as compared to the weight of the opposite lobe; after that, organization and healing began and the weight diminished. Prior to the third week, the essential histologic change was one of necrosis and hemorrhage. The necrosis was confined to the central portion of the affected area and appeared as an amorphous material, in which all structural elements were lost, even the blood-vessels. This area of complete necrosis merged almost imperceptibly into a peripheral zone of necrosis, resembling the microscopic picture of an early infarct, in which shadows of former acini and remains of blood-vessels could be distinguished. Scattered throughout were fibrin and red blood-cells. The outer border of this zone contained many fragmented nuclei, lymphocytes, a few plasma cells and an occasional polymorphonuclear leucocyte. Immediately peripheral to this was a narrow zone of hemorrhage, lying in a tissue architecturally distorted, but showing only slight degenerative histologic changes.

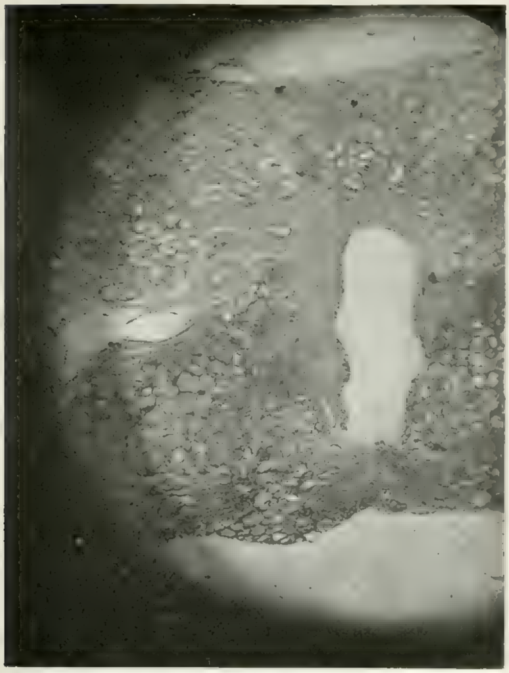
Chart I

Dog	Date of Operation	Control	Mg. Hrs. Radium	Glands Removed	Weight Radiated Gland, Gm.	Weight Control Gland, Gm.	Area of Destruction, Mm.	Weight Dog, Kilo.	Remarks
I	4/22/21	Steel needle	25	10th day	1.39	1.34	1.0×2.0	14.8	
II	4/29/21	Steel needle	25	14th day	0.755	0.715	1.0×2.0	14.0	
III	5/3/21	Steel needle	50	14th day	1.29	1.13	2.0×4.0	13.6	
IV	5/5/21	Dog used as control to compare weight of glands. One weighed 1.93 gm.; the other 2.09							
V	5/10/21	0.3 c.c. quinine urea hydrochloride	112	14th day	0.84	0.61	4.0×3.0	14.6	Control gland small, indurated and densely adherent
VI	6/22/21	Steel needle	100	70th day	0.69	0.780	4.0×3.0	9.7	
VII	6/24/21	0.3 c.c. quinine urea hydrochloride	112	21st day	1.025	1.592	2.0×2.0	14.3	Dog prostrated, wound clean, hemorrhage around control gland
VIII	6/24/21	0.3 c.c. boiling water	106	28th day	0.935	1.273	2.5×3.0	15.0	
IX	7/16/21	Steel needle	100	84th day	0.475	0.840	3.0×2.0	11.8	Radiated gland appeared pale and bloodless: calcification
X	3/11/22	Steel needle	125	73d day	0.197	0.215	3.5×2.5	11.3	
XI	3/16/22	Steel needle	150	68th day	0.325	0.695	4.0×2.5	14.0	
XII	3/30/22	Steel needle	168	75th day	....	....	4.0×5.5	....	Radiated gland pale: calcification
XIII	5/4/22	Steel needle	150	210th day	0.16	0.735	1.0×0.5	...	Gland extremely small and pale

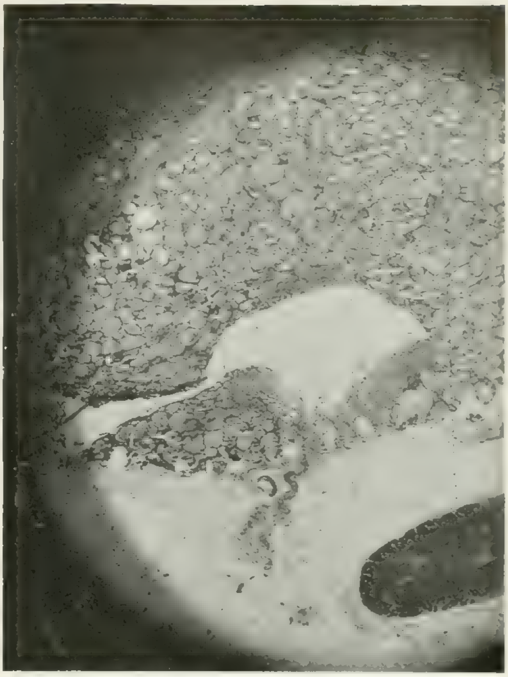
Chart II

Dog	Amount Radium Used, Mg.	Screen	Date Inserted	Date Removed	Mg. Hours	Tissue Excised	Area Destroyed, Mm.	Remarks
XIV	50	1 mm. brass	4/20/22	4/21/22	1200	4/26/22	13×16	Dog in good health when killed
XV	50	1 mm. brass	4/27/22	4/28/22	1200	5/8/22	16×19	Dog survived partial pancreatectomy, dying in December, 1922, in an emaciated condition. At autopsy no remnants of pancreas could be found

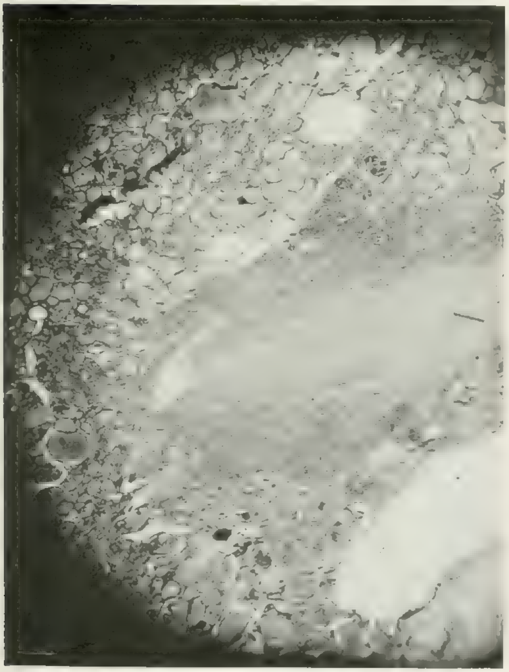
Segments of acini remained, showing swollen cuboidal epithelium with deeply staining nuclei. Other acini were intact but much shrunken. Colloid was scant or entirely lacking and the vesicles contained



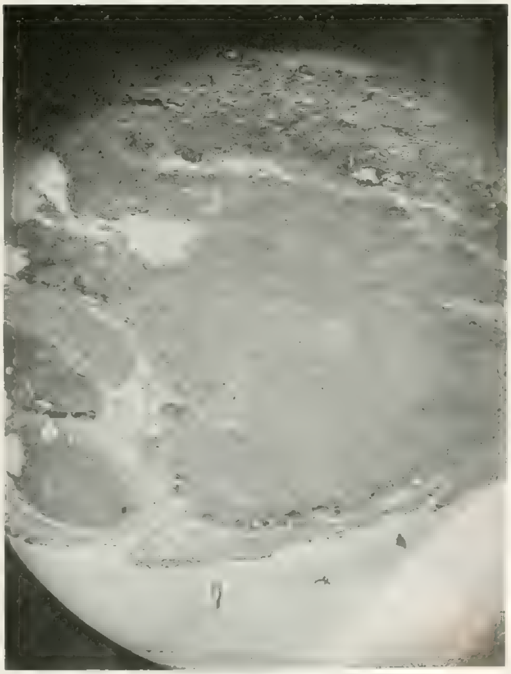
Dog I. 25 mg. hrs. Gland removed 10th day.



Dog II. 25 mg. hrs. Gland removed 14th day. Note sharp line of demarcation between normal tissue and destroyed area.

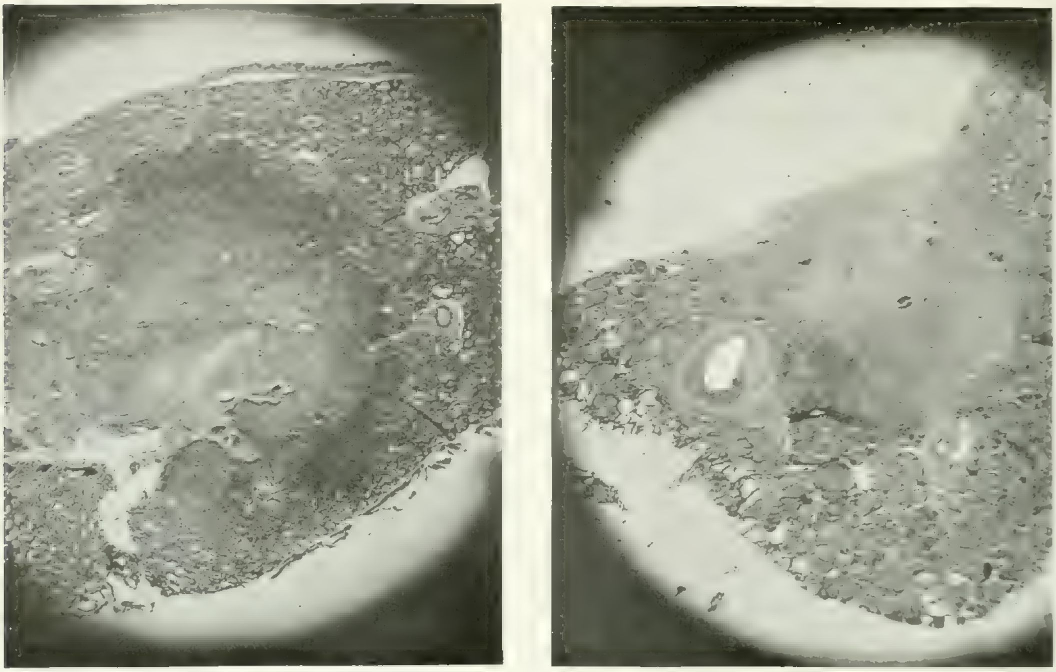


Dog III. 50 mg. hrs. Gland removed 14th day.



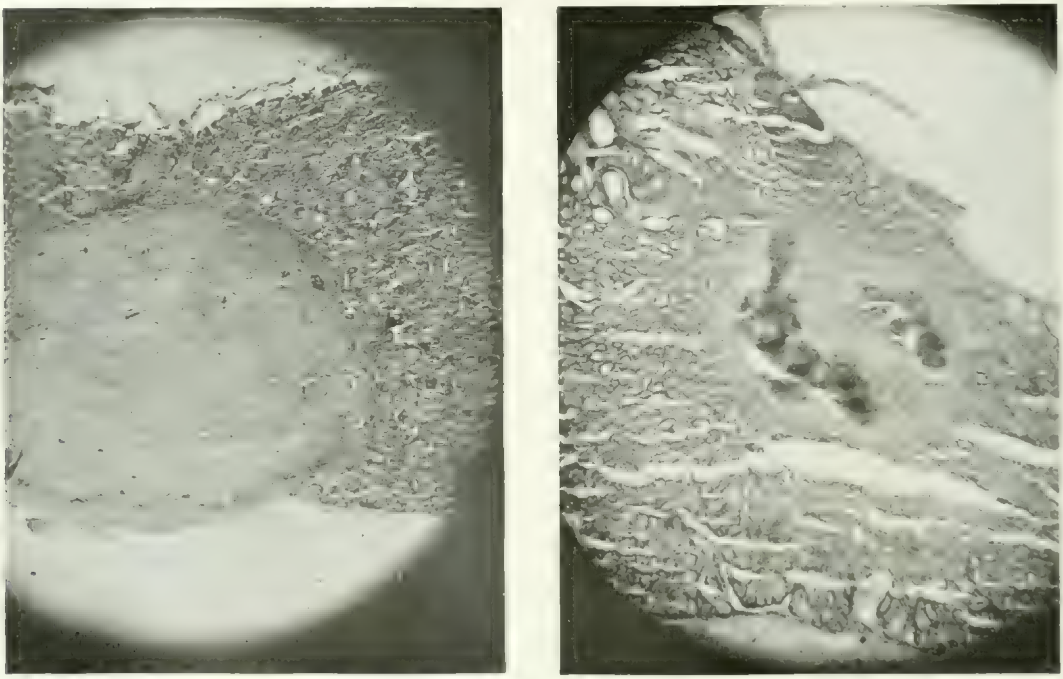
Dog V. 112 mg. hrs. Gland removed 14th day. Note increased area of necrosis compared to Dog III.

Fig. 1. Effect of varying exposures of the thyroid of dogs to raduim.



Dog VI. 100 mg. hrs. Gland removed 7th day. Note wide zone of hemorrhage.

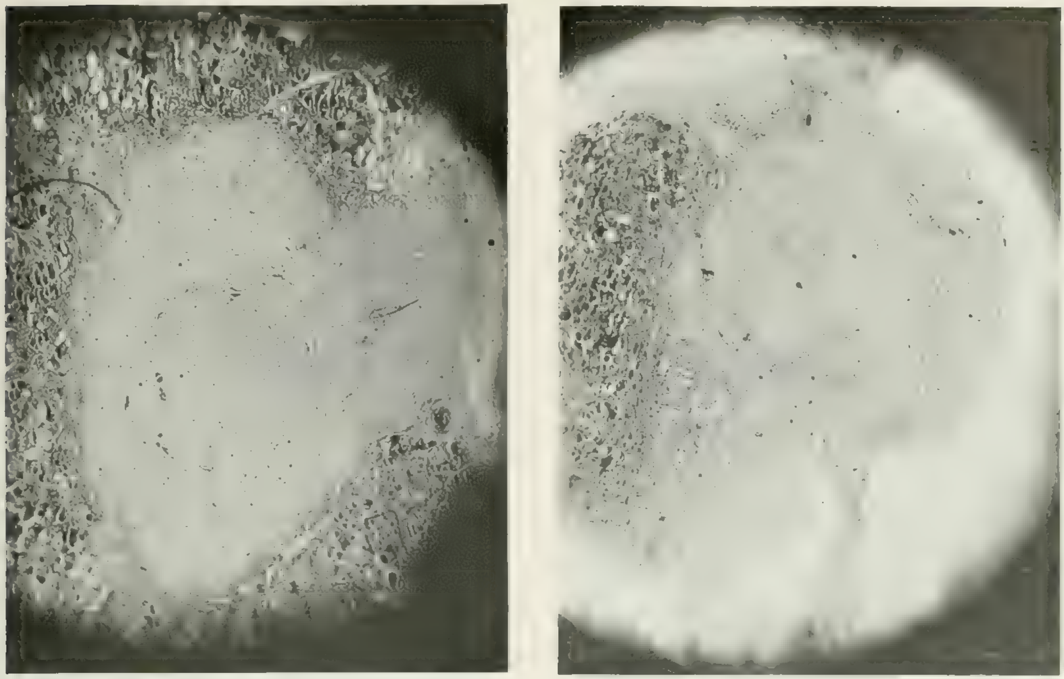
Dog VII. 112 mg. hrs. Gland removed 21st day.



Dog VIII. 106 mg. hrs. Gland removed 28th day. Note sharp line of demarcation between healthy and necrotic tissue.

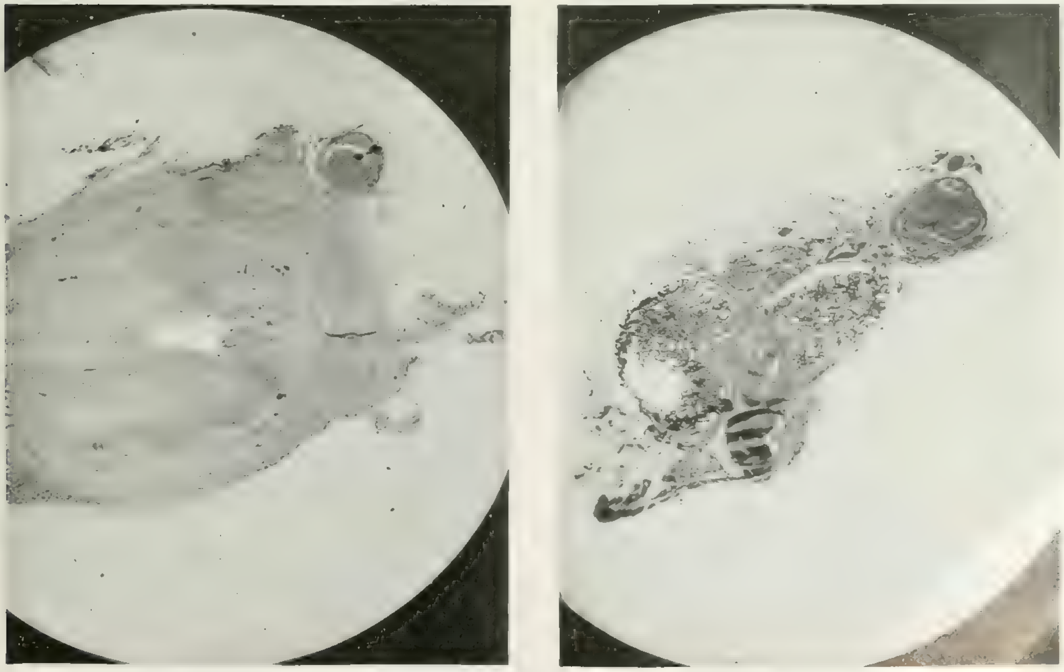
Dog IX. 100 mg. hrs. Gland removed 84th day. Note areas of calcification.

FIG. 2. Effect of radium on thyroids removed at varying periods of time. Mg. hrs. exposure practically identical.



Dog X. 125 mg. hrs. Gland removed 73rd day.

Dog XI. 150 mg. hrs. Gland removed 68th day. Compare with dog IX.



Dog XII. 168 mg. hrs. Gland removed 77th day. Calcification present.

Dog XIII. 150 mg. hrs. Gland removed 210th day.

FIG. 3. Effect of increased dosage on thyroid of dogs.

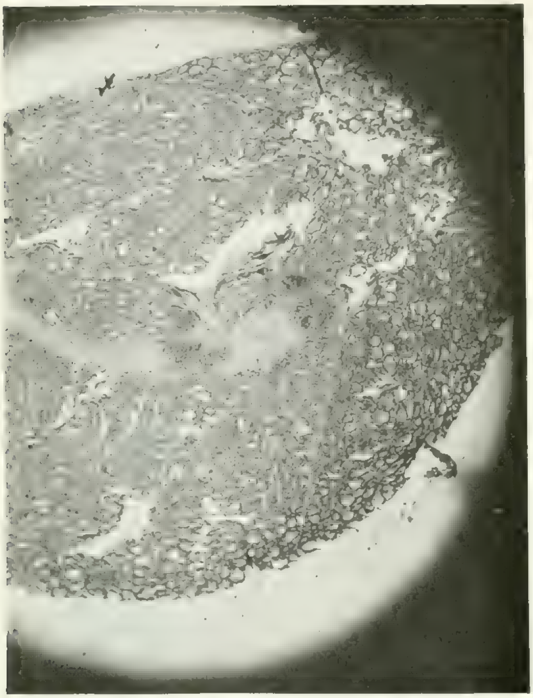


Fig. 4. Effect of steel needle in thyroid for 8 hrs. Gland removed 7th day

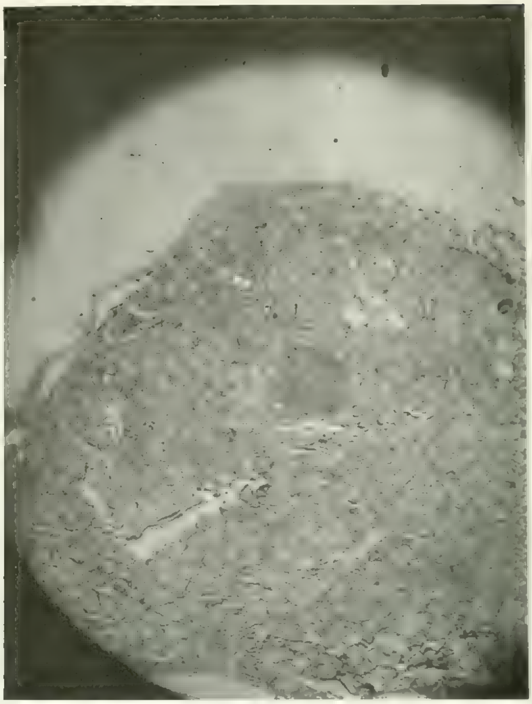


Fig 5. Effect of 0.3 c.c. of 0.3 per cent quinine and urea hydrochloride. Gland removed 14th day.

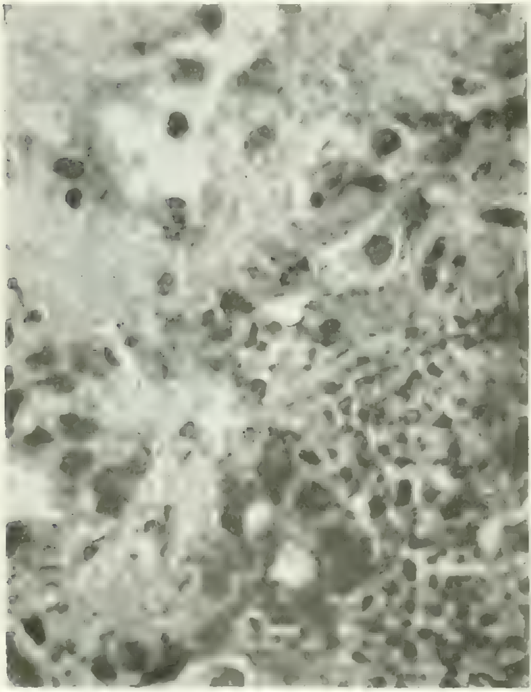


Fig. 6 High power photomicrograph of border of affected area in thyroid. Note hyperchromatic nuclei and mononuclear cell infiltration.

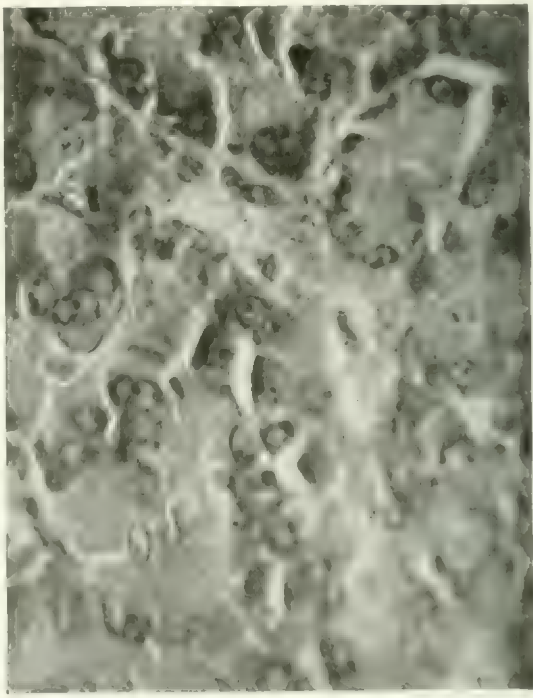


Fig. 7. High power photomicrograph of pancreas well beyond area of necrosis produced by radium. Most nuclei show hyperchromatism, although some exhibit poor staining qualities. In many the nucleolus alone remains, surrounded by a nuclear membrane.

many red blood-cells and occasional degenerated vacuolated large mononuclear phagocytes. Beyond this, the acini appeared normal. They were lined by a flattened cuboidal epithelium, resembling that at the periphery of the gland, and showed no degenerative changes in either nuclei or cytoplasm. They were filled with colloid material of almost the same density as that at a distance, although occasional red blood-cells and phagocytes were present. The thyroid vesicles, distant from the zone of hemorrhage about the depth of two acini, were normal as far as we could determine by ordinary staining methods. The degenerative changes in the nuclei of epithelial cells, namely the vacuolization and apparent dropping out of the nuclear material, so often found in radiated malignant tissue, were not noted, nor was any constant change observed in the blood-vessels as reported by Williamson, Brown and Butler[8] in their work on the brain of dogs.

About the third week, organization and healing began by a proliferation of fibroblasts from the periphery. The necrotic material was partially removed by phagocytosis and was replaced by connective tissue with a deposition of lime salts in two cases. A few blood-vessels became occluded by a subintimal proliferation of fibrous tissue. Again cells beyond the zone of repair showed no nuclear or cytoplasmic changes. No change was observed in the parathyroid glands.

The effect of radium compared with that produced by quinine and urea hydrochloride and boiling water injections was striking. Boiling water produced no demonstrable microscopic lesion at the end of one month. In the two cases in which quinine and urea hydrochloride was used, the amount of destruction was microscopic only, consisting of a loss of colloid in two or three acini, with granular swelling of the epithelial cells and infiltration with plasma cells. This may be due to the small amount of solution used, 0.3 c.c., because large areas of necrosis are encountered in the thyroid of man following this treatment. In addition, the glands so treated were rather densely adherent to the surrounding tissue, similar to cases of exophthalmic goiter treated by *x*-ray in man, while glands treated by radium were in all instances free from adhesions. Terry[7] has drawn attention to this freedom from adhesions following implantation of radium emanation tubes.

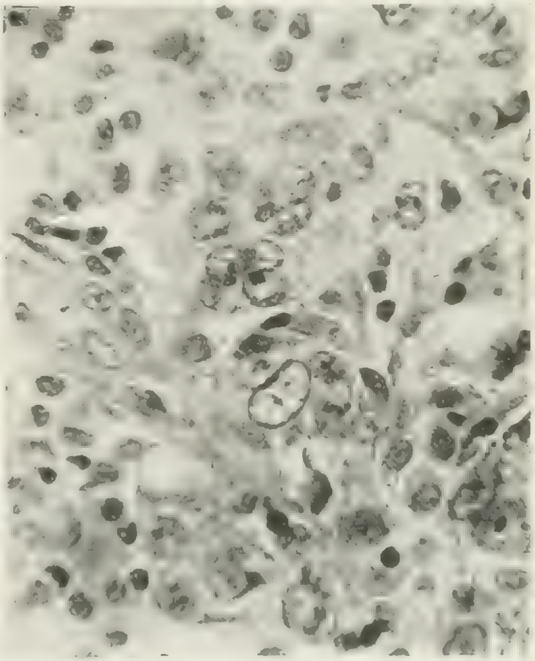


Fig. 8. Section of metastatic carcinomatous lymph-gland 0.5 cm. from needle insert. Note open vacuolated nuclei, some showing a nucleolus, others simply a nuclear membrane.

DISCUSSION

Richards[9] states that the effects of radium are due to (1) the strength of the radium, (2) the duration of exposure, (3) the distance of the object (or tissue) from the source of radiation. To these we may add (4) the type of tissue or tumor, for it is well known that different types of tissue, and consequently different types of cells, react differently to radiation. Ewing,[10] in discussing the factors influencing the results of radium therapy states that "one of the most prominent of these questions concerns the relation of the structure of tumor or tissue to the reaction of radium." Schmitz[11] says that the type of cell is most important. Epithelial cells are more receptive to radium—to use the term of Dominici—than the connective-tissue cells. Bergonié and Tribondeau state that immature cells and cells in an active state of division are more sensitive to the rays than cells that have already acquired adult fixed morphologic or physiologic characteristics. The basal cells of hair follicles and the epidermis, lymphoid cells, ova and spermatozoa are readily killed by an amount of rays which leave intact the surrounding mature cells. Schmitz[12] says the nearer the cells are embryonal in type, the more receptive they are to rays and undergo more readily cytolysis and destruction. Colwell and Russ[13] state that very rapidly growing cells are most affected by radium. Ewing[10] confirms this by saying that "tumors responding most readily to the simplest test of therapeutic efficiency and diminution in size are usually cellular and rapidly growing tumors."

Not only is the type of cell composing the tissue or tumor important in considering the reaction to radium, but also the structure of the tissue itself. Quite early in the treatment of malignant tumors by radium, it was recognized that certain types of tumors responded very readily to radium rays, while others were refractory. Hanford[14] states that marked improvement may be expected in carcinoma of the breast recurring after operation. Ewing[10] had explained this by saying: "Early and rapidly growing metastases of mammary carcinoma may often respond readily to radium, whereas older tumors which have become fibrous may show very little or no reduction in size after persistent radiation." Schmitz[11] classes the radiosensitive tumors as epidermoid and basal-cell epithelioma, lymphosarcoma from embryonal lymph-cells; sarcomata from embryonal connective tissue cells in which connective tissue fibrillæ, cartilaginous and osseous tissue have undergone absorption; fibromata in which fibroblasts are present in large numbers and do not develop into adult cells. Janeway[15] considers the clearest example of the selective action of radium on tumor tissue to be furnished by the cellular teratoma and lymphosarcoma which "seem to melt away with the greatest rapidity, whenever, one might almost say, radium is anywhere in their vicinity." Ewing[16] has obtained retrogression of deep-seated tumors, particularly mediastinal lymphosarcoma, carcinoma of the lung and abdominal metastases from carcinoma of the testes, after massive doses of radium. Although Simpson,[17] in his chapter on Intratumoral Radiation, makes no mention of the histologic character of the growth, Ewing[10] feels that not only is the type of tumor tissue important, but also the stage in its growth when treated, for "very striking differences are often observed in the reaction of recent as compared with old tumors of Hodgkin's granuloma malignum, and this difference accords with the natural change of structure, the older tumor becoming fibrous." In this same article he indicates the types of tumor reactive to radium treatment and those that are resistant. The majority of authors agree that squamous-cell epithelioma, whether skin or cervix, is resistant to the action of radium (Hanford,[14] Schmitz,[11] Ewing[10]). Wood[18] states that basal-cell carcinoma containing keratin resists radium, but is uncertain whether the keratin is the resisting substance or is a result of radium treatment, for the sections of the tumor were examined after radiation. Chondroma is supposed to be refractory to radium, but will respond satisfactorily if one will take sufficient time for treatment (Ewing[10]). Fibrosarcoma, particularly of the spindle-cell variety is considered resistant to radium, says Schmitz[11] and Ewing,[10] as are also fibroma containing atrophic fibroblasts and much connective tissue (Schmitz[11]). Ewing[16] feels that radium may change a malignant into a relatively benign tumor; while Bumpus[19] shows that massive doses of radium in carcinoma of the prostate produced marked proliferation of fibrous bands. He states: "These malignant cells are atypical in appearance, being pressed and squeezed into distorted shapes by an ever-increasing proliferation of connective tissue cells. The reproductive function of the malignant cells is undoubtedly impaired and if all malignant tissue can be thus affected, complete cessation of the process must occur."

These remarks, we hope, will indicate the importance of considering not only the type of cell composing the tissue, but also the architectural structure of that tissue, when endeavoring to determine the effect of radium.

In addition to histologic structure, one must consider the physiological characteristics of a tissue in studying the effect of radium rays. Prime[20] showed that there was "great difference in the quantity of radium required to kill the physically functioning cells, such as heart muscle, and a merely growing cell, such as is found in connective tissue or in malignant tumors." He felt that radium did not kill the cell outright, but injured the nucleus in such a manner as to prevent further division, which must eventually result in the death of the cell. In experimenting with mouse cancer, von Wassermann[21] found that after exposure to radium the cells remained alive, but did not take; and he concluded that the genuceptors were killed. The Hertwigs[22] advanced the hypothesis that the effect of radium was a direct one on the chromatin of the nucleus. Schwarz[23] thought that radium decomposed the lecithin (present in all cells and particularly rapidly growing ones) into cholin and trimethylamine and that the action of radium was due to the liberated cholin. Gager, quoted by Richards[9] concluded from a review of the literature in 1908, that radium seemed to retard the activity of the enzymes, although Löwenthal and Edelstein[24] in the same year found increased autolysis after exposure to radium emanation. This varied markedly with the character of the material subjected to autolysis; the most marked increase occurring in human cancer. Packard[25] suggested that radium radiations act indirectly on the chromatin and protoplasm by activating autolytic enzymes, which bring about a degeneration of the complex proteins, and probably by affecting other protoplasmic processes in the same manner. Richards and Woodward[26] found that weak radiation increased enzyme activity and strong inhibited it; and Richards[9] concluded that the modifiability of enzymes played an important part in radium effects, although the chromatin changes were undoubtedly important. Pendergrass *et al*[27] offered as a working hypothesis of the action of radiation on living tissue "that it is due to a primary effect upon the nucleus and the resultant death of the cell under conditions favoring autolysis."

Based on the modification of enzyme activity, it was argued that a tissue rich in ferments should theoretically show greater effects from radiation than one poor in ferments. Histologically, the thyroid is composed of closed follicles, lined by a flattened cuboidal epithelium, embedded in a rather compact connective tissue stroma. So far as is known, the thyroid produces no known ferment. In contrast to the thyroid is the pancreas, enclosing, in a light stroma of connective tissue, abundant glandular epithelium, which manufactures three strong ferments. It was deemed of interest to note the effect of radium on the pancreas. The accompanying Chart II shows the results obtained in two experiments.

REMARKS

In studying the effect of radium on the normal thyroid tissue, the most striking feature observed was the apparent resistance to the rays. In all glands examined, there was an abrupt line of demarcation between destroyed and healthy tissue. Only the cells immediately surrounding the necrotic area showed degenerative changes. Beyond this and almost immediately, the epithelial cells appeared normal in every respect. Terry[7] noted this fact and states: "The transition from complete necrosis to undamaged tissue is sharp." Lacassagne[28] buried radium emanation tubes in the muscles of rabbits, and also found a sharp line of demarcation between necrotic and apparently healthy tissue.

Bumpus,[19] in an adenocarcinoma of the prostate treated thirty-one days before death with 700 mg. hrs. of radium, showed that a limited area was affected by the large dosage. Photomicrographs of areas beyond the influence of the radium showed active viable cells exhibiting mitosis; but sections taken close to the area affected by radium showed loss of cell outline, poor staining qualities and fragments of destroyed cells. Quick[29] has noted hydropic degeneration, necrosis, shrinkage and nuclear pycnosis in carcinoma of the breast forty-nine days after implantation of radium emanation tubes. Bagg[30] experimented with buried emanation tubes in Flexner Jobling rat carcinoma, after a successful take. Tumors 1 cm. in diameter showed irregular areas of necrosis seven days after burying a tube containing 0.3 mc. The outlying cells showed marked hypertrophy and hyperchromatism of the nuclei, while the cell bodies were large and hydropic. He felt that radiation was effective for a distance of 1 cm., similar to the reaction in normal tissue.

Colwell and Russ[13] noted in tissue exposed to hard beta and gamma rays, a primary serous infiltration with enlargement of the cell nucleus and body; a swelling of the endothelial cells of the capillaries with a decrease in the size of the lumen. In seven to eight days there was degeneration of the cell nucleus, cessation of mitosis, pycnosis, cytolysis and achromatism. The cytoplasm exhibited vacuolation and granulation. The reaction was an inflammatory process with fibroblastic proliferation. Fibrosis resulted, but at a distance one saw epithelial cells, isolated or in small groups, exhibiting all stages of degeneration. Williamson, Brown and Butler[8] found that brain cells at a distance of 0.5 cm. from the radium capsule showed distinct and marked nuclear changes when the brain was removed three weeks following 200–900 mg. hrs. of surface application beneath the dura. Pendergrass *et al*[27] noted "distinct evidence of involvement of the various tissues of the brain, at least as far again as the areas of necrosis and hemorrhage seen grossly."

In sections of the pancreas removed seven and fourteen days after radiation, cells were observed well beyond the area of necrosis and hemorrhage, which showed degenerative changes of both nuclei and cytoplasm. In one case of metastatic carcinoma of the breast to the axillary lymph-glands, operated upon by one of us, section of the gland removed two weeks after 300 mg. hrs. of needle implantation showed dissolution of the chromatin of the nuclei almost 1 cm. from the site of insertion of the needle. Comparing our findings with those of others, one can not help but be impressed with the apparent resistance of the thyroid to radium rays. Whether this resistance is due to the colloid contained in the thyroid, to the adult fixed character of the cells composing it, or to a deficiency in autolytic ferments, we are not prepared to state; but comparison of results with those obtained in other organs and tissues rich in enzymes and autolytic ferments would point toward the latter as a possible explanation.

CONCLUSIONS

1. The primary changes induced by radium in the thyroid are hemorrhage and necrosis. Organization and healing are evident in the third week and complete about the twelfth.

2. The normal thyroid gland is distinctly resistant to the action of radium; it is not a good tissue for the study of the finer histologic changes produced by radium; the nuclear degenerative changes, characteristic of radiated malignant tissue, were never seen.

3. No toxic symptoms of any sort were observed.

4. No changes were demonstrable in the parathyroids.

5. The apparent resistance of the thyroid tissue to radiation would make it appear that implantation would be superior to surface applications, and that relatively large dosage must be employed to assure any extensive effect upon the gland.

We are greatly indebted to Dr. J. Edwin Sweet, in charge of the Department of Surgical Research, under whose direction this work was done.

BIBLIOGRAPHY

1. Abbe, Robt. *Arch. Roentg. Ray*, 1904–05, ix, 214.
2. Burrows, A. *Radium*, May, 1918, No. 2, xi.
3. Aikins, W. H. B. *Radium, Pittsburgh*, 1918–19, xi, 81.
4. Aikins, W. H. B. *Med. Press*, London, 1920, N. S. Ex. 25.
5. Clagett, A. N. *J. Radiol.*, 1920, i, 121.
6. Terry, W. I *J. Am. M. Assn.*, 1921, lxxvi, 1821.
7. Terry, W. I. *J. Am. M. Assn.*, 1922, lxxix, 1.
8. Williamson, Brown and Butler. *Surg., Gynec. & Obst.*, 1921, xxxi, 289.
9. Richards, A. *Science*, 1915, lxii, 287.
10. Ewing, J. *Radium*, Aug., 1918, No. 5, xi.
11. Schmitz, H. Am. J. Roentgenol., 1920, vii, 52.
12. Schmitz, H. *Charlotte (N. C.) M. J.*, 1919, lxxix, 161.
13. Colwell and Russ. Radium, X-Ray and the Living Cell. New York, 1915.

14. Hanford, C. W. *Surg., Gynec. & Obst.*, 1920, xxx, 210.
15. Janeway, H. H. Radium Therapy in Cancer Memorial Hospital. P. B. Hoeber, N. Y., 1917.
16. Ewing, J. *Proc. Soc. J. Cancer Research*, 1919, iv.
17. Simpson, F. E. Radium Therapy of Skin. St. Louis, 1922.
18. Wood. *Proc. Soc. J. Cancer Research*, 1919, iv.
19. Bumpus, H. C. J. Collected Papers, Mayo Clinic, xiii, 380. Philadelphia, 1921.
20. Prime, F. *J. Cancer Research*, 1917, ii, 107.
21. von Wassermann. *Deutsch med. Wchnschr.*, 1914, xi, 524.
22. Hertwig, O *.Arch. f. mikr. Anat.*, 1911, lxxvii, 165, 197, 301. Ibid., 1912, lxxix, 201.
23. Schwarz *.Arch. f. Physiol.*, 1903, c, 532.
24. Löwenthal and Edelstein. *Biochem. Ztschr.*, 1908, xiv, 484.
25. Packard. *J. Exper. Zoöl.*, 1914, xvi, 85.
26. Richards and Woodward. *Bull. Biol.*, 1915, v, 28.
27. Pendergrass, Hayman, Houser and Rambo. Am. J. Roentgenol., 1922, ix, 553.
28. Lacassagne, A. *J. de radiol et d'electrol.*, 1921, v, 160.
29. Quick, D. *Surg., Gynec. & Obst.*, 1921, xxxii, 156.
30. Bagg, H. A. Am. J. Roentgenol., 1920, vii, 536.
31. Marine and Lenhart. *Johns Hopkins Hosp. Bull.*, xxii.
32. Marine, D. *Cleveland M J.*, vi.
33. Marine, D. *Johns Hopkins Hosp. Bull.*, xviii, 359.
34. MacKee, G. M. X-Rays and Radium. Treatment of Diseases of the Skin. New York, 1921.
35. Desjardines, A. W. Collected Papers, Mayo Clinic, xiii, 1207. Philadelphia, 1921.
36. Wetterer. *Handb. d. Röntgentherapie*, Leipzig, 1908.
37. Richards and Woodward. Am. J. Roentgenol., 1917, iv, 564.
38. Richards, A. *Am. Jour. Physiol.*, 1915, xxxvi.
39. Levin and Joseph. *J. Am. M. Assn.*, 1917, lxiv, 1068.
40. Masson, R. C. *Arch. Middlesex Hosp.*, 1914–15, xxxiii–xxxiv, 110.
41. Lazarus, W. S. and Barlow. *Arch. Middlesex Hosp.*, 1914–15, xxxiii–xxxiv, 34.
42. Webster, J. H. D. *Arch. Radiol. and Electroth.*, 1920–21, xxxv, 346.
43 Dominici. *Arch. gén. de méd.*, 1900, xxxvi, 404.
44. Levin and Levine. *Ann. Surg.*, 1918, lxvii, 422.

A RADIUM APPLICATOR FOR SMALL LESIONS

BY NATHAN T. BEERS, M.D., F.A.C.P.

Dermatologist to the Brooklyn Hospital, the Methodist Hospital and the Broad Street Hospital

NEW YORK CITY

ONE of the noticeable effects of the campaign of cancer education is the increasing number of patients who consult the dermatologist for small lesions about the face. It has been my experience that a majority of these lesions are less than one centimeter in diameter; and to treat them properly with radium one must either make use of a leaden window-screen or provide an applicator sufficiently small in size to cover but the lesion itself. Many of the lesions are very awkwardly situated about the eyes, ears, nose and lips, where the conformation of the parts makes their approach with anything but a very small applicator exceedingly difficult. To attempt their treatment with plaques of standard size necessitates the use of a window-screen to protect the surrounding healthy tissues, and very frequently, this cannot be placed in such position as to insure the proper approximation of the radium.

In a previous issue of this journal (January, 1922) Drs. Quick and Johnson of the Memorial Hospital, N. Y., described a method for the rapid destruction of small lesions by the use of a very small glass bulb containing 600 mc. of radium emanation. An exposure of two minutes was sufficient to clear up entirely a rodent ulcer 8 or 10 mm. in diameter; and, with a freshly prepared bulb, they were able to treat from 40 to 50 cases in an afternoon. Aside from the enormous saving in time, this method insures accurate application of the radium to any visible lesion.

The little applicator herein described was the result of an attempt to adapt their *multum in parvo* idea to plaque form, hoping thereby to gain the facility and accuracy of approximation which they have proven are possible of attainment with applicators of small dimension. Since there is an upper limit to the amount of radium which can be used per unit (12½ milligrams per square centimeter being the maximum which has been found practical), the saving of time with a plaque of the greatest possible concentration is hardly to be compared with that obtained with the emanation applicator described above. However, it is considerably greater than can be gotten with the ordinary standard plaque applied with a window-screen.

The applicator which I have been using with much satisfaction for the past year or more is circular in form and approximately one centimeter in diameter. From its back projects a lug which is one-quarter of an inch in diameter and threaded to facilitate its attachment to almost any type of handle or supplementary retaining-applicator. The radium element is incorporated in a glaze which is fused in a shallow recess on the face of the plaque. Because of its small size and light weight, a thickness of double-faced adhesive-plaster is usually all that is required to retain it firmly in position (Fig. 1). Should screening be desirable, the filter can be mounted upon the face of the plaque between two discs of double-faced adhesive, or it may be placed within the shallow cap of hard rubber made to fit snugly over the applicator. When round plaques are used I find it expeditious to cut the filters and adhesive plaster in disc form the exact size of the plaque with circular, open steel punches. Window-screens, when required, may be cut out in the same way. This insures greater accuracy in application.

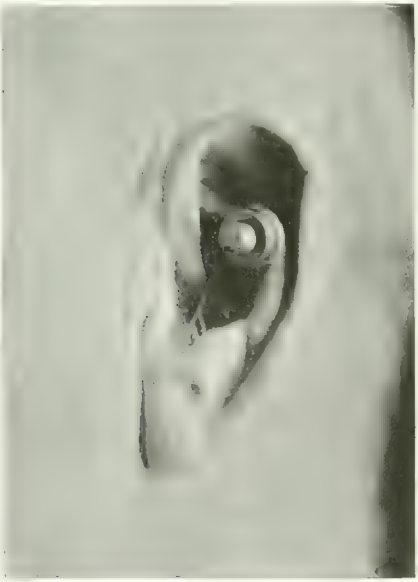
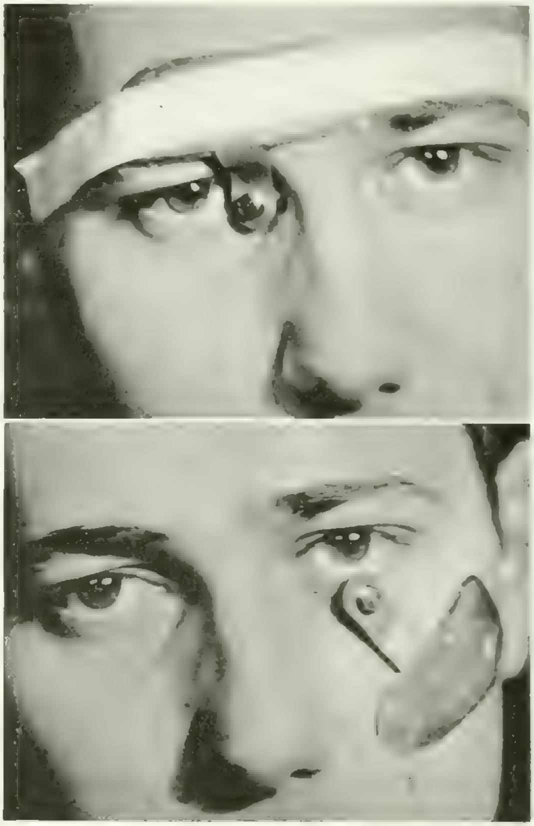


Fig. 1. Showing method of applying the small plaque by means of double-faced adhesive plaster. (In this case two thicknesses of the adhesive were used with 0.1 aluminum between them.)

When lesions about the eyelids are to be treated, some form of retaining device is often required. To those who are mechanically inclined, many such devices will suggest themselves. The T-shaped finger-plate shown in the accompanying illustrations (Figs. 2 and 3) is rather crude, but it has served me very satisfactorily for a year or more and has, I believe, some points of advantage over more complicated appliances. It may be cut very quickly from one millimeter sheet lead, to suit the case in hand. It is light in weight, it permits of easy moulding with the fingers to fit the parts and it will retain its position indefinitely when properly applied. After the plate has been cut and moulded to the parts, the corners and edges should be rounded off with a rasp and a hole punched in the end of the finger to receive the plaque. The hole should be punched a trifle smaller than ¼ in. in diameter and then threaded with a ¼ × 40 machine-tap. A few turns of the tap will yield a thread sufficient to hold the plaque snugly when screwed home. A thickness of



Figs. 2 and 3. Showing the use of the lead finger-plate to insure accuracy of approximation about the eye.

the double-faced plaster applied over the back of the plate is sufficient to retain it firmly in position, but added security may be gained by adding a strip of ordinary adhesive over the whole. A disc of the double-faced plaster the exact size of the plaque is then cut and placed over the face of the plaque, serving instead of the usual rubber screen and at the same time insuring an approximation of the radium which is both close and secure. The patient's hands are free, and he may lie down or move about as he pleases without fear of disturbing the applicator.

For the treatment of the small vascular angiomas of infancy and childhood, this little applicator is particularly serviceable. If the lesion is smaller than the plaque, a window-screen will be needed; but it will be so small in size and so light in weight that its proper placing and retention is a simple matter. It may be made up very neatly and quickly from one millimeter sheet-lead and a thickness of the double-faced plaster. The plaster is laid on the lead and a disc cut with the plaque-sized punch. Then with a smaller punch, the exact size of the lesion, the window is made. Our window-screen now resembles a corn-plaster with an adhesive base, and permits of great accuracy in application—an important factor in treating these conditions. When the window-screen has been satisfactorily and firmly placed, the plaque, covered with a disc of the double-faced plaster, is applied. With children it is best to add an extra strip of ordinary zinc oxide adhesive, punching a ¼ in. hole in its center through which the lug may protrude.

AUTOMATIC OPERATION OF THE POTTER GRID

BY PAUL C. HODGES, M.D.

From the Department of Roentgenology, Peking Union Medical College

PEKING, CHINA

DR. POTTER'S moving grid, which suppresses much of the scattered radiation so objectionable in roentgenograms of thick parts, is now well known to roentgenologists everywhere. The present article describes a simple modification of one of the commercial types of his instrument, to facilitate its routine use in hospital practice.

The device, as supplied by the manufacturers, is a separate unit designed to be placed on top of the exposing table. The grid is cocked against spring pressure, and when released by the tripping of a trigger, moves through an arc between the object and the film at a speed which is controlled by regulating the valve of an oil drag. This valve is calibrated in terms of time for complete grid excursion, or in other words, in terms of grid speed.

If there are to be no grid shadows on the film, the grid must start to move before the beginning of the exposure and continue uniform motion until the exposure is completed. To accomplish this, the following procedure is necessary. One determines the time of exposure required (say three seconds), sets the oil drag valve at about four seconds, pulls the string to trip the grid trigger and then closes the *x*-ray time switch. Practically, it is difficult to obtain proper synchronism between grid and exposure; furthermore, the grid unit is heavy to lift on and off the table, and the patient is very uncomfortable unless supported by pillows or concave blocks. It was an obvious improvement to build the grid unit into a special table with concave top. Many such tables have already been described; but it seems equally obvious that the grid can be made to control the exposure automatically. This we have done; but as yet, no other such attempt has come to my attention.

Our table is a standard article of American manufacture with cast-iron base, wooden top and metal guide-ways at one side, along which moves the mast of the tube stand. This we remodelled as follows: the top of the table was removed, the base castings were cut off, and a substantial iron frame was added, to which the grid unit was securely bolted, so that its center was 44 in. from one end of the table and 32 in. from the other end. A segment of wooden block, 31 in. long, as wide as the grid unit, and with the same surface concavity was bolted to the frame, filling the space between the grid and one end of the table. A similar segment, 19 in. long, was fitted to the other space on the frame, but was not bolted in place. The piston rod of the oil drag was lengthened $17\frac{1}{2}$ in. and a hole drilled in the grid frame to allow this lengthened rod to project. This provided a member which moves out as the grid is cocked, and back into the frame with uniform speed proportional to the speed of the grid, when the grid is released.

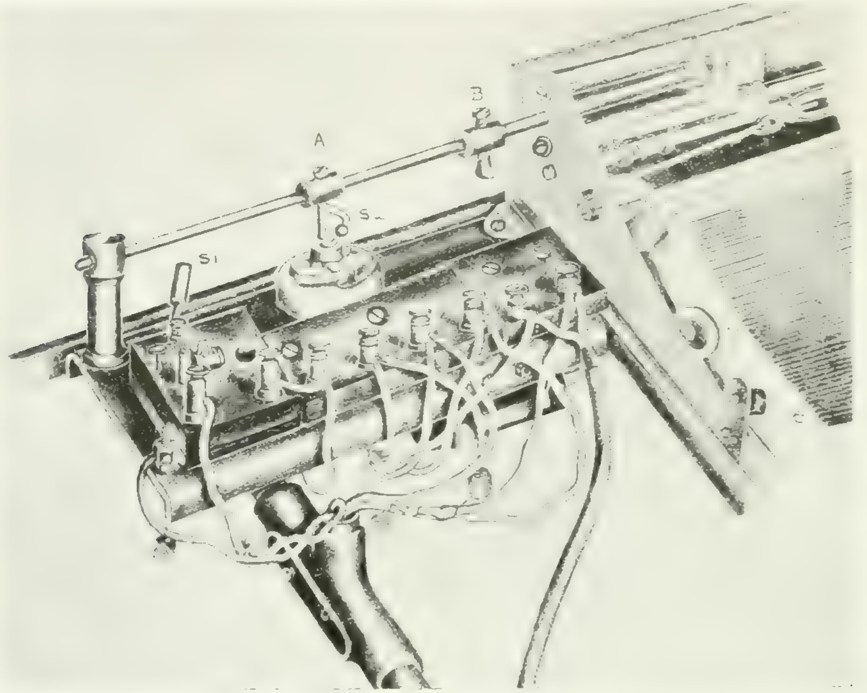


Fig. 1. Sketch showing grid at the end of its travel, just after lever A has opened switch No. 2. Note: In the cocked position, lever A holds switch No. 1 open; and lever B snaps switch No. 2 to the closed position.

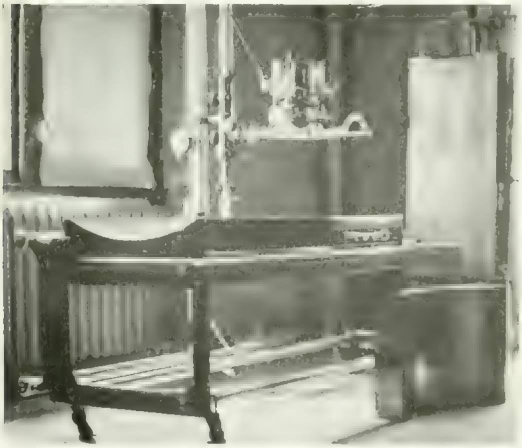


Fig. 2. Table with built-in grid. One wooden block (the smaller one) has been removed to show the switch mechanism.

A sheet metal shelf was riveted to the table frame beneath the extension of the piston rod. To this were fastened a support-bearing for the end of the rod and two switches: No. 1, designed to close automatically by spring pressure, No. 2, a common English snap switch, which stays either on or off. These switches were wired in series with each other and with the magnetic circuit of the remote control switch of the *x*-ray machine. Closing both switches closes the *x*-ray remote control switch and produces *x*-rays to the tube; while opening either stops the rays.

Two levers were attached to the piston rod, so arranged that, with the grid cocked, switch No. 1 is open; No. 2, closed. The grid release trigger was provided with a solenoid release, instead of the string supplied by the manufacturer, and the button for this solenoid was placed on the *x*-ray control board. By pressing this button, the grid is released and starts to move. Simultaneously, the lengthened piston-rod moves; switch No. 1 is automatically closed by its spring; *x*-ray goes on; the grid nears the end of its travel; switch No. 2 is opened; *x*-ray goes off; the grid stops.

In cocking the grid, the lever A opens switch No. 1 just before lever B closes switch No. 2, so that the *x*-ray switch is not turned on in the process of cocking.

The oil drag was recalibrated in terms of *x*-ray exposures. Thus, the new procedure is reduced to: Determining the exposure; setting the oil drag valve; cocking the grid; and pressing the button of the magnetic grid release. The grid, by its motion, automatically puts the *x*-rays on and off.

A SIMPLIFIED ROENTGENOGRAPHIC TECHNIQUE BASED ON EXPERIMENTAL EVIDENCE*

BY FRANK LIBERSON, M.D.

Roentgenologist of U. S. Marine Hospital, No. 21 and Marine Hospital No. 70

NEW YORK CITY

IT IS needless to mention the numerous techniques that have been developed by the pioneers in roentgenography. Everyone knows that there are as many different roentgenographic methods for a particular part as there are roentgenographers. In this paper I will not add to the number of techniques for particular parts, but will try to point out a method which is easily applicable to every part of the body, does not include any burdensome tables, is mastered after a very short period of its application and automatically decides the quality and intensity of radiation to be used for a particular part. This method also automatically decides when to use intensifying screens to get optimum contrast and still retain detail.

I. The greatest difficulty which a beginner in roentgenography encounters is the exposing in stout patients, especially, of those parts which cannot be brought close to the plate; for instance, hip-joints, kidneys, and laterals of the spine, especially those of the lumbar-sacral junction. The difficulty is primarily due to either or all of the following reasons:

1. Many roentgenographers use a fixed spark-gap: especially is that true with those that have non-rectifying machines; and they correct for the increase of thickness by increasing the milliampere seconds, but they do not consider the importance of voltage in obtaining proper negatives.

2. Others correct for the increase of thickness of the part to be taken by increasing the spark-gap (voltage); but the difficulty they encounter is the estimation of the necessary increase for a particular thickness.

3. Either method mentioned above rarely increases properly the intensity for the increased thickness of the part. They either leave target plate distance the same for all different thicknesses, or they increase the target plate distance in stout patients: a condition which leads to diminished intensity (fewer rays per square area), which, in turn, gives a diminished effect on the emulsion of the film or plate, and these effects are, of course, the reverse of what is desired.

With a view of eliminating the above-mentioned difficulties, and in order to show the practical rôle that variation of distance plays in exposure, the writer investigated the subject by making exposures under a variety of conditions, studying the effects on plate and on film with special reference to contrast and detail. The exposures thus made were of two main groups:

---

* Approved for publication by the Surgeon-General, U. S. P. H. S.

(*A*) *Blank Exposures* (exposures made with only air between the tube and plate or film).

(*B*) *Interposed Exposures* (substance of same density as body tissue; as paraffin or water placed between the tube and plate or film).

(*A*) In comparing the effects of the various *Blank Exposures* it was found that the effect on the plate or film is the same whether we use a 3 in. gap at 20 in. target plate distance or a 5 in. gap at 33 in. target plate distance, the milliampere seconds of exposure being equal. The effect is also the same when we use a 4 in. gap at 20 in. target plate distance as with a 5 in. gap at 25 in. target plate distance, the milliampere seconds of exposure being equal. Also, the effects on the plate or film are similar when using a 6 in. gap at 20 in. target plate distance as a 5 in. gap at slightly less than 17 in. target plate distance, the milliampere seconds of exposure again being equal.

Gap, in.	T. P. D., in.	=	Gap, in.	T. P. D., in.
3	20		5	33
4	20		5	25
6	20		5	17 —

In other words, by using a constant 5 in. gap and varying the target plate distance we can get the same effects on the emulsion as when using a constant distance and varying the gap.

Figure 1 shows in the upper row a non-interposed exposure at standard distance with variation of the spark-gap, using 5 milliampere seconds for each exposure; while the lower row shows a constant 5 in. gap with variation of the distance; the milliampere seconds of exposure being 5 as above. From this figure it is quite evident that the effect on the plate or film in non-interposed (blank) exposures is *nearly* the same when using a constant gap and varying the target plate distance between 16 and 33 in. as by the use of a constant distance and varying the spark-gap between 6 in. and 3 in.

(*B*) In studying the effects of the interposed exposures we find similar results as when using "blank exposures," although the factors of scattering and secondary radiation are more pronounced on account of the interposed medium.

Figure 2 shows an interposed exposure in which tap water (almost the same density as living tissue) in columns 2, 4 and 6 in. respectively, was used as the interposing medium. A piece of the distal end of a tibia was placed in the fluid in order to compare the penetrability and intensity, and their combined effect on the emulsion. The odd rows beginning from above show the results of the variation of the gap at a 20 in. distance, while the even numbered rows beginning from above show the results of the variation of distance on a constant 5 in. gap, the milliampere seconds of exposure proportional to the thickness which will be described later. But the milliampere seconds of exposure are the same in row 1 as in 2, in 3 as in 4, in 5 as in 6. The results in detail and contrast are as good as by varying the gap; and with increase of the interposed thickness, we get greater detail by diminishing the distance than by increasing the gap; possibly on account of the greater scattered radiation produced by currents of high spark-gaps which blur the image.

II. From observations thus far presented, we calculated a formula which has served us admirably in finding the necessary target plate distance, in order to get the best penetration and intensity. Penetration and Intensity Formula:

$8G - 3M = D(A)$ for bone radiography.
$8G - 2M = D(A')$ for soft tissue radiography.

Expressed in words, it means that eight times the spark-gap minus three times the solid mass interposed (that includes bones, muscles, fat etc., but not air) equals the required target plate distance, T. P. D. or, in short, D. for bone radiography (A). And eight times the gap minus two times the thickness of mass to be radiographed equals target plate distance for soft tissue radiography (A′). It is always best to use the minimum voltage (spark-gap) that will be sufficient to give the desired penetration, rather than the maximum; as the former gives better contrast and good detail.

But how is one to know what gap to use in a given case? If a definite T. P. D. is desired, one can find it by reversing the formula (A) $\frac{D + 3M}{8} = G$

For example: The part to be radiographed is 4 in. thick, measuring it in the direction of the central ray, and the desired T. P. D. is 20 in. then gap = $\frac{20 \text{ in.} + 3 \times 4 \text{ in.}}{8} = G = 4$ in. = necessary gap for that thickness. But if, on the other hand, a 3 in. gap is desired, or no other is available, and we wish to radiograph a part of 4 in. in thickness, then we shall have to calculate for distance in order to get the proper radiation intensity. The distance as calculated by the formula for bone radiography will be:

$$8G - 3 \times 4 \text{ in.} = D = 8 \times 3 - 12 = 12 \text{ in. T. P. D.}$$

Similarly, if we wish to find out whether a 2 in. gap is sufficient, apply formula as above, again calculating for distance, namely, $8G - 3M = D$. $8 \times 2 - 3 \times 4$ 4 in. T. P. D. or D. But the part alone takes up 4 in. If we could place the target immediately over the part to be radiographed, we would get the necessary intensity; but this is impossible, as the target is usually about 2 to 4 in. away from the wall of the tube, and, in addition, a cone or a lead diaphragm may be wanted between the tube and part. We therefore have to account for the distance between the target and the end of the cone, also for the thickness of the part which we want to radiograph. Assuming that there is 10 in. between the target and end of cone, the combined shortest target plate distance possible is 10 in. + 4 in. or 14 in. T. P. D. Now, if we want to find out the value of the necessary gap at that distance, we apply formula (A) reversed: $\frac{14 + 3 \times 4}{8} =$ $G = 3\frac{1}{4}$ in. required spark-gap at 14 in. T. P. D. in order to radiograph a part, the thickness of which is 4 in. Thus, to estimate the necessary gap, we add the T. P. D. we intend to use to 3M and divide by 8. If we want t oradiograph a part 10 in. thick, we would have 10 in. from target to skin and 10 in. the part itself, and 3 × 10 according to formula (A)—altogether 50 in.; dividing

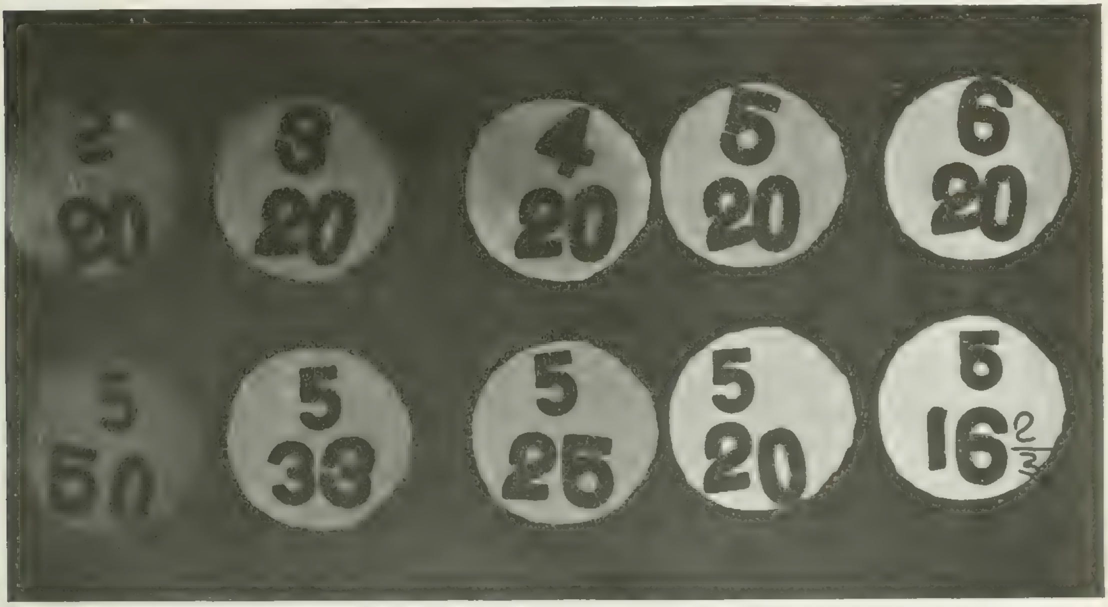


Fig. 1. The upper numbers in each circle denote the gap in inches; the lower numbers denote the distance between target and film in inches. Five-milliampere current was used for one second in every one of the ten exposures. The film was placed in a single thin paper envelope. Note the comparative density between each upper exposure and its corresponding lower-row exposure.

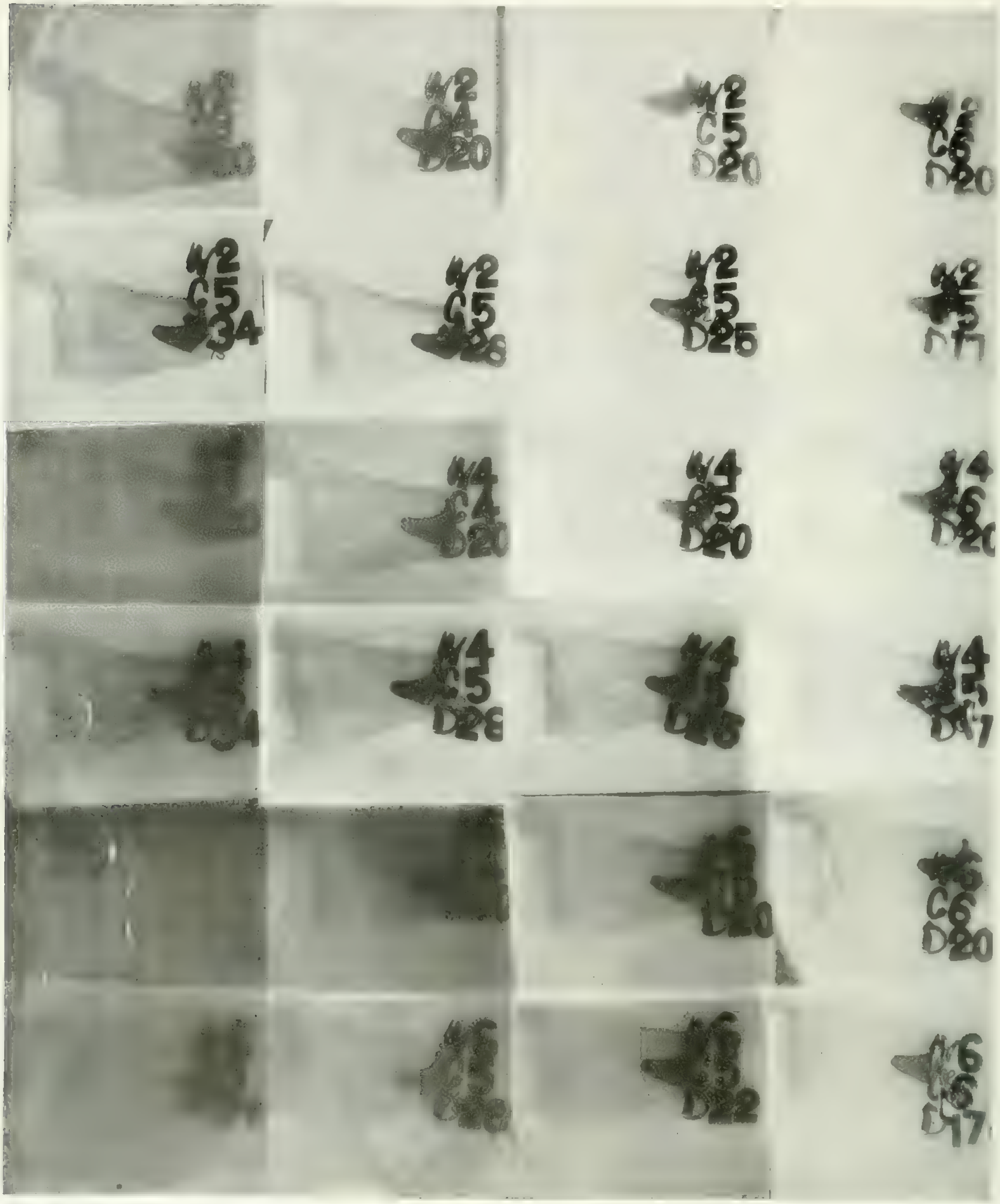


Fig. 2. The top number in every exposure represents the volume of the water phantom in inches. The second number represents the gap in inches and the third number represents the distance in inches. Note that in the odd rows there is a variation of the gap on a constant distance, while in the even numbered rows beginning from above, there is a variation of the distance on a constant gap.

50 in. by 8 = 6¼ in. = the necessary gap for that thickness at 20 in. T. P. D.

$$\frac{10 + 10 + 3 \times 10}{8} = G = 6\tfrac{1}{4}\text{ in.}$$

Manipulating the above formula, therefore, we find that varying either target plate distance or gap, similar satisfactory results are obtained, as far as contrast and detail are concerned. In the course of its practical application it was found that using a fixed gap, say 4 or 5 in. and varying the T. P. D. served our purpose well. Our formula for penetration and intensity for bone radiography was (*A*)

$8G - 3M =$ T. P. D. or D. Using a 5 in. gap formula reads: 8×5 in. $- 3M =$ T. P. D. or $40 - 3M = D$.

Example in computing target plate distance on a constant 5 in. gap:

Knee-joint, anteroposterior, centered perpendicularly half an inch distad to inferior border of patella. If it is 4 in., the computed target plate distance will be: according to formula (*A*), i.e., 40 in. $- 3 \times 4$ in. = 28 in. target plate distance, in which 40 = gap distance for 5 in. gap, 3 = factor used in bone radiography, 4 = thickness of the part.

Another example: A knee-joint is 6 in. thick, ½ in. below the patella in the direction of the normal ray. The computed target plate distance will be:

$40 - 3 \times 6$ in. = 22 in. target plate distance

Another example: Hip taken for bone detail if it is 6, 7 or 8 in. our target plate distance will be:

$40 - (3 \times 6$ in.$) = 22$ in. target plate distance

$40 - (3 \times 7$ in.$) = 19$ in. target plate distance

$40 - (3 \times 8$ in.$) = 16$ in. target plate distance

In the last case, it is evident that the computed 16 in. target plate distance cannot be applied, because the diameter of the hip takes up 8 in. of space and there is only 8 in. left between the body and the target. This distance is not sufficient for the average tube stand with cone. In such and similar cases, the difficulty may be overcome in one of the two ways:

1. By increasing the spark-gap to 6 in. and using 8×6 or 48 instead of 40 as gap distance factor and computing thus: $8 \times 6 - 3 \times 8 =$ T. P. D., i.e., $48 - 24 = 24$ in. T. P. D.

2. Or in case no higher gap is available, use a double screen and change the gap distance factor to 8×8* or 64 instead of 40 and compute thus:

$64 - 3 \times 8 = 40$ in. target plate distance with double screen.

III. We, among others, F. H. Kuegle,[1] I. S. Hirsch[2] and W. W. Mowry,[3] have found that the milliampere seconds of exposure are also proportional to the thickness of the mass, providing proper penetration is used. If we multiply the thickness of the mass by the emulsion factor† and divide the product by the milliamperes of the machine used, the quotient will equal the number of seconds of exposure necessary to give the optimum energy, thus:

Formula B $\dfrac{E \times M}{MA} = T$. Expressed in words it means that the emulsion factor† times the mass divided by the milliamperes of the machine equals the number of seconds = T.

Example for seconds of exposure we take from Figure 2. In the first two rows the thickness of the mass was 2 in., the emulsion factor for the films was 40, the milliamperes of the machine were 20 and the number of seconds of exposure was:

---

* At this point it is important to review some of our findings in the experiments with intensifying screens. Using Edwards screens we noticed that there is an entirely different relation between the exposure factors (such as thickness of the part, spark-gap, target plate distance and milliampere seconds of exposure) and the unaided film on one hand; and between exposure factors and screened films on the other hand. For example, by using 1 in. gap at 40 in. target film distance with 2 mm. of aluminum as filter, there is no particular difference between the unaided and aided films. On a 2 in. gap the screened film shows only an intensity five times as much as the unaided film on a 2 in. gap. On a 3 in. gap the effect of the screened film is the same as the use of an unaided film with a 4 in. gap and five times as much exposure. With a 4 in. gap the intensity of the screen is the same as by using a 7 in. gap and five times as much exposure. This of course gives some idea of the dissociation of the relation between the factors of exposure on the one hand and the aided and unaided film on the other hand when noninterposed exposures are made. When a 5 in. gap is used with a double screen in interposed exposures, its effect on the film is the same as the use of an 8 in. gap with no screen. (Unpublished communication.)

† The emulsion factor is obtained by exposing on one plate or film a hip of 6 in. thickness and a toe of 1 in. thickness, and also some intermediate part of 3 in. in thickness. The target plate distance and time should be calculated according to method above mentioned, using 30 as a temporary emulsion factor. If the density of the hip and toe is the same, the emulsion factor for these films is 30. If the hip appears less dense, make similar exposures on another film or plate (whatever is used in the particular laboratory) increasing the number to 35, 40, 45, 50 or 55, etc., until the density between the hip-bones and those of the toe is uniform; and whatever number was used to give this uniform density is the emulsion factor.

$$\frac{2 \times 40}{20} = 4 \text{ seconds}$$

In the middle two rows the thickness was 4 in. on the same setting and the number of seconds of exposure was:

$$\frac{4 \times 40}{20} = 8 \text{ seconds}$$

In the lower two rows the thickness of the volume was 6 in. on the same setting and the number of seconds of exposure was:

$$\frac{6 \times 40}{20} = 12 \text{ seconds}$$

Now let us see how the formula is applicable for practical radiography.

Part	Position	Thickness, In.	Corrected Thickness, In.	T. P. D. Formula, In.	T. P. D., In.	Exposure Formula, In.	Seconds*
1. Finger	P. A.	$\frac{1}{2}$	$\frac{1}{2}$	$40 - (3 \times \frac{1}{2})$	$= 38\frac{1}{2}$	$\frac{40 \times \frac{1}{2}}{40}$	$= \frac{1}{2}$
2. Wrist	P. A.	$1\frac{3}{4}$	$1\frac{3}{4}$	$40 - (3 \times 1\frac{3}{4})$	$= 34\frac{3}{4}$	$\frac{40 \times 1\frac{3}{4}}{40}$	$= 1\frac{3}{4}$
3. Wrist	Lateral	$2\frac{3}{4}$	$2\frac{3}{4}$	$40 - (3 \times 2\frac{3}{4})$	$= 31\frac{3}{4}$	$\frac{40 \times 2\frac{3}{4}}{40}$	$= 2\frac{3}{4}$
4. Elbow	A. P.	$2\frac{3}{4}$	$2\frac{3}{4}$	$40 - (3 \times 2\frac{3}{4})$	$= 31\frac{3}{4}$	$\frac{40 \times 2\frac{3}{4}}{40}$	$= 2\frac{3}{4}$
5. Shoulder	A. P.	5	5	$40 - (3 \times 5)$	$= 25$	$\frac{40 \times 5}{40}$	$= 5$
6. Knee	A. P.	4	4	$40 - (3 \times 4)$	$= 28$	$\frac{40 \times 4}{40}$	$= 4$
7. Hip	A. P.	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
8. Toe	P. A.	1	1	$40 - (3 \times 1)$	$= 37$	$\frac{40 \times 1}{40}$	$= 1$
9. Mastoid	Lateral	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
10. Spine	Lumbar A. P.	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
11. Spine	Cervical Lat.	4	4	$40 - (3 \times 4)$	$= 28$	$\frac{40 \times 4}{40}$	$= 4$
12. Spine	Mid-dorsal Lat.†	12	$\frac{12}{2} = 6$	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
13. Chest for soft parts	P. A.	6*	$\frac{6}{2} = 3$	$40 - (2 \times 3)$	$= 34$	$\frac{40 \times 3}{40}$	$= 3$
14. Abdomen for kidney	A. P.	6	6	$40 - (2 \times 6)$	$= 28$	$\frac{40 \times 6}{40}$	$= 6$

* The time of exposure would appear rather long. It is due to the use of old films which render the emulsion less sensitive.

† In the upper and mid-dorsal spine the lungs are on both sides of the bodies of the vertebrae, therefore we have to subtract from the lateral diameter of the chest the approximate thickness of the volume of air of the right as well as of the left lung approximately 6 in., or half the entire lateral diameter. In the lower dorsal laterally, the rays have to traverse solid organs: the liver, stomach and spleen; therefore no deduction should be made, and entire lateral diameter is to be considered excepting the gas bubble in the stomach, which is best eliminated by compression, displacing the bubble anteriorly to the bodies of the last dorsal vertebrae.

Figure 3 was made of a patient, height 5 ft. 7 in., weight 160 lbs. All the fourteen exposures were made on a single film and calculations made in the manner herein tabulated, using a 5 in. gap and 40 milliamperes on a D. C. machine. (For a. c. deduct $\frac{1}{4}$ of exposure time.)

From this figure it is quite evident that by using the above method we can not only get uniformity in the appearance of the radiograms, but we can also avoid the effects of poor judgment on the part of the one who develops the plates or films. Since all the fourteen exposures were taken on one film, the dark-room man could do very little to help or hinder any single exposure by under- or over-development. The developing is therefore done by time which is proportional to the intensity and temperature of the developer, and is entirely automatic.

SUMMARY

I. Variation of the milliampere seconds of exposure alone is not sufficient to give uniform roentgenograms, and the penetration has also to be varied.

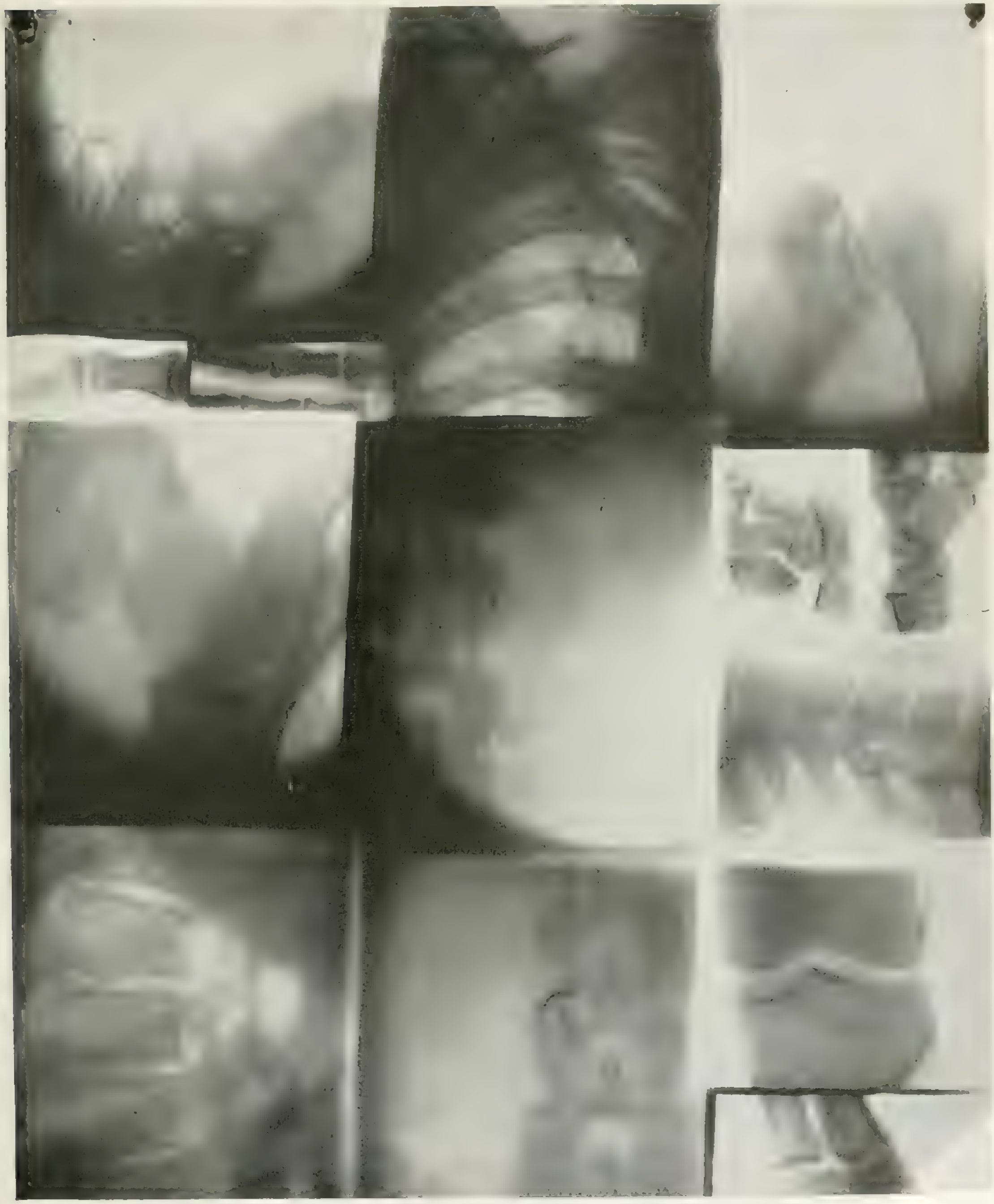


Fig. 3. All the fourteen exposures in this figure were made on one film. Note that the density of the finger is nearly the same as the density of the hip, also A. P. and lateral of wrist are similar.

II. A tangible formula is offered for estimating the factors necessary for optimum results:

(*A*) The proper target plate distance *for bone detail* is obtained by multiplying the thickness of the part by 3 and the product subtracted from the gap by 8.

(*A′*) The proper target plate distance *for soft parts* is obtained by multiplying the thickness of the part by 2 and the product subtracted from the gap by 8.

(*B*) The milliampere seconds of exposure are obtained by multiplying the thickness of the part by the factor of the emulsion (for films from 30 to 40, plates 40, 50 or more); the product is then divided by the milliampere current of the machine, and the quotient is the number of seconds.

III. Finally, the diameter of the thickness of the mass of tissue to be radiographed offers an easy and fairly accurate index to the necessary gap, distance and time of exposure.

The aim of this paper would be fully realized if it should stimulate its readers to further investigation of this convenient and simple technique.

BIBLIOGRAPHY

1. Kuegle, F. H. The standardization of tube and plate technique. *Interstate M. J. St. Louis*, 1917, pp. 386–392.
2. Hirsch, I. Seth. Principles and Practice of Roentgenological Technique, New York, 1920.
3. Mowry, W. W. Quoted by Hirsch (2).

RESULTS OF SKIN TESTS MADE TO DETERMINE AN OBJECTIVE DOSE FOR RADIUM RADIATIONS

BY ARCHIE L. DEAN, JR., M.D.

Memorial Hospital

NEW YORK CITY

In a previous publication certain generalizations were mentioned for the comparison of doses of radiation administered under different conditions. At that time it was considered inadvisable to discuss in detail the results of the biological tests made to compare radium radiation filtered through various thicknesses of brass and rubber.

We know that filtration is the factor which determines the quality of the radiation used. It is noteworthy that, unfortunately, there is little unanimity of practice regarding the choice of substances used as filters and their thickness. Workers who employ one type of filter find it difficult or impossible to compare therapeutic advances achieved elsewhere where a different filter has been used, because there is no means of translating the doses into common units.

It was with the idea of developing a method for interpreting different filtrations of radium rays by the same terms that this work was undertaken. Since no physical instrument has been devised for the purpose, we employed an empirical method, utilizing a biological indicator, namely the human skin, and as a standard dose, the radiation sufficient to cause a faint erythema.

It is well known that the degree of erythema produced on the skin of different patients by the same dose of radiation is not always the same. Therefore there must be a dose of radiation such as will produce no visible effect on the skin of the less radiosensitive patients, and a slight, but definite effect on the skin of the more radiosensitive patients. If we adopt this type of reaction as our standard of comparison, we can eliminate almost entirely the personal element on the part of the observer. In the experiments it was only necessary to determine whether an erythema did or did not appear following the application of a certain dose of radiation to the skin of many patients. If no erythema appeared on the skin of *all* patients treated, the dose was too low; if *every* patient showed an effect, the dose was too high. By repeated trials it is possible to determine the dose which produces an effect on 50 per cent of all patients, while the others show no apparent effect, the individuals being chosen at random. To be sure of such a dose, however, it is necessary to test a large number of patients in each case for doses differing slightly from each other. Bearing in mind the practical applications of these experiments, it is evident that such extreme refinement is unnecessary. Accordingly it is sufficient to determine the dose which produces an erythema in the majority of patients, but still produces no visible effect on a certain percentage of the individuals treated. The latter point is very important, because it indicates that the dose is not too high, without relying on the intensity of redness observed.

It may be contended that one observer may see an erythema where another does not. In these experiments such errors are negligible, because, on account of the type of the applicator used, the small area affected by the radiation was completely surrounded by normal skin. Another precaution consisted in making the tests always on the same part of the body: the volar aspect of the forearm immediately below the antecubital fossa, on account of the different sensitivity exhibited by different skin areas of the same individual. Personal differences of the patients were taken account of by treating a large number of subjects of all ages and both sexes, who were suffering from a great variety of tumors in all stages. Normal persons were not available, ambulatory cases were unsatisfactory, and very weak patients were not likely to survive our period of observation. Therefore the finished records were obtained from those in a fair general state of health, and the doses arrived at may be considered as for the average cancer patient.

The erythema upon which the dosage is based appears usually within the fourth week after irradiation, but variations of one week earlier or later are not uncommon. In a considerable percentage of cases the erythema proceeds to the stage of bleb formation, and then subsides. This requires usually about a week. Then bronzing appears and may persist for an indefinite period. In some cases it has been noticed distinctly twenty-four months following these tests. Telangiectases have never been observed after our applications. The texture of the skin months afterward is normal, even when slight pigmentation persists. On account of the time required for the maximum effect to manifest itself, these experiments have extended over a period of nearly three years.

The experimental conditions for these tests were as follows: In a cork 4 cm. in diameter and 2 cm. high, a hole 2 cm. in diameter was bored. A thin silk ribbon was fastened across the top, and a slot was provided into which the brass filters were fitted. As secondary filters, discs of pure gum rubber were used, fitting into the hole of the applicator to make up the desired thickness. The source of radiation was, in every case, a tube of radium emanation 14 mm. in length and 0.5 mm. in external diameter, whose value in millicuries was known accurately. It was fastened to the silk ribbon with a little paraffin, so that it was always at a distance of 2 cm. from the skin of the patient. This distance was adopted in order to minimize errors due to possible variations in the distance of application. The applicator is shown in cross-section in Figure 1.

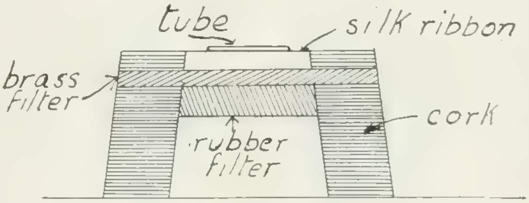


Fig. 1.

At the outset the dosage for each filtration which would produce the effect required, namely, the faint erythema, was not known and could not be predicted. Therefore the determinations were made entirely empirically. Whenever possible, clinical knowledge gained from radium treatment at the hospital was employed. For every filter, and the bare tubes, a rough estimate was made of a safe dose. This dose was administered to a number of patients, and depending upon the absence of any visible reaction or the quality of the skin effect which followed, alterations were made in the quantity of radiation applied.

The technique employed was as follows: a patient was chosen for the test; the emanation tubes were measured; the desired filter was arranged for one tube and the other was left bare; the tubes were attached to their respective silk shelves with melted paraffin. Then the applicators were attached to the patient's forearm with adhesive plaster strips, using care not to lessen the skin distance by exerting too great pressure. As each applicator was attached to the forearm by one operator, another began timing with a stop watch.

The patients were occasioned no discomfort by these manoevers, and the subsequent examinations were usually made at the same time that a dressing was done.

Observations were begun at the end of twenty-four hours and after the first two days were continued at forty-eight-hour intervals until all akin reaction had ended.

On the basis of these tests the millicurie-hour doses corresponding to different filters, obtained in this manner, are shown in Table I.

Table I

Filter		Erythema Dose, Mc. Hours
Brass, Mm.	Rubber, Mm.	
0	0	7.5
0.16	1.2	30.0
0.32	1.2	100.0
0.50	1.2	250.0
0.75	2.4	425.0
1.0	2.4	630.0
2.0	2.4	800.0

It will be noticed that between the millicurie-hour dose for unfiltered radiation and that for radiation filtered through 2.0 mm., brass and 2.4 mm. rubber, there is a difference of more than a hundred fold. On this account it would have been very difficult to have kept the time of application approximately the same for all the tests made. Actually the applications with filtered radiation were considerably longer than with unfiltered rays, but, within the limits of time variation of these experiments, this had no detectable effect on the dose. Special tests were made before this conclusion was reached.

If we analyze the results of Table I, we find the millicurie-hour doses increase with the filter for two physical reasons: (1) The radiation reaching the skin through the filter is less in amount. (2) It is also more penetrating, and hence a smaller amount will be absorbed by the tissues. Since the biological effect is brought about by the radiation which is absorbed by the tissues, the millicurie-hour doses of Table I are related to the radiation which is effective in producing the observed changes. Furthermore, in the tests, all the physical conditions but one—the filtration—were kept the same, and therefore the millicurie-hour doses are inversely proportional to what we may call the "effective radiation" corresponding to the different filters.

The figures of Table I enable us to define the standard erythema dose objectively. It is that intensity of redness of the skin resulting from a radium application under the conditions described above, giving the dose which corresponds to the filtrations used. For instance, if a radium tube of 50 mc., whose total filtration is 2 mm. of brass, is available, it should be applied to the patient at a distance of 2 cm. (center of tube to skin surface) for sixteen hours to obtain the standard erythema. To make the conditions as nearly like those of the experiments as possible, the proper distance should be obtained by means of a cork support as already described, and the secondary filter should be 2.4 mm. of rubber. Tests should also be made on several patients, in order to get an idea of the average erythema obtained. If a thinner brass filter is available it should be used in preference to the thicker one, as the millicurie-hour dose will be smaller and the test will be more convenient. However, the unfiltered radiation from a radium tube does not quite correspond to that from an emanation tube, because the glass is thicker and the salt itself absorbs more of the radiation. The dose here given for unfiltered radiation, therefore, cannot be checked by those who do not use the emanation.

Each patient employed was tested with unfiltered as well as with the filtered radiation. The reason for this was that the erythema dose of the unfiltered radiation had been worked out previously, and therefore the reaction obtained from this known erythema dose was used to check up our findings on the opposite forearm where the filtered rays were applied. In other words, this enabled us to tell whether or not the patient was especially radiosensitive, and the proper dose for filtered radiation could be arrived at more easily.

The "erythema dose" for the unfiltered rays was determined in the same empirical manner as mentioned above. It was found to be 450 millicurie minutes, or 7.5 millicurie hours for the 2 cm. skin distance.

We found that the unfiltered radiation caused the primary erythema to appear usually twelve to thirty-six hours after application, with twenty hours as the average, that it persisted for about three days and then disappeared, leaving no sign. Simultaneously with the advent of the secondary erythema resulting from the filtered radiation, there usually appeared a similar erythema on the forearm treated with the bare tube. This might or might not progress to bleb formation. It often was followed by bronzing of the skin.

Before comparing more closely the effects upon the skin of the filtered and unfiltered radiation, it might be pertinent to record our ideas concerning the tissue changes that are associated with the different radium reactions:

1. The primary reaction appears a few hours after treatment and is never stronger than an erythema. It seems to be a simple vaso-dilatation resulting from irritaton, and is not a specific result of radiation. If the dosage was light, this primary erythema disappears in two or three days leaving no sign, but if the irradiation was heavy, it will persist longer or may pass into

2. The secondary reaction. This varies largely with the quantity of radiation, and is but slightly altered by its quality. It may be of any degree, from the faintest erythema to the loss of considerable tissue. It follows the primary reaction at intervals, shorter with large doses, longer with smaller doses. This secondary reaction may be thought of as a local vaso-motor paralysis with dilatation of the blood-vessels, which in the more aggravated cases progresses to exudation of serum, hemorrhage, swelling of the endothelial cells with resulting occlusion of capillaries, the destruction of collogen fibers, and the endothelial and muscle cells of the vessels. Such changes appear as exfoliation of the dermis, and they progress to ulceration and necrosis.

3. Tertiary reactions now rarely occur. They have never been seen in these tests. During the earlier years of radium therapy they occurred with some frequency and followed the administration of a large dose of radiation. Occasionally they are reported in the literature as delayed radium burns. They appear about a year after irradiation and are manifest by ulceration at the site treated. The immediate cause is probably an obliterative endarteritis which cuts off nutrition to the part, necrosis following.

In contrasting the skin effects of the radiation produced in our tests by the bare and the screened radium emanation, we are really comparing the skin reactions of beta and gamma rays. Such a comparison might be of value in a study of the different reactions to the rays themselves, or might form the basis of a practical test, the use of which would assist in computing the dose of radium required to treat the individual patient.

In undertaking this experimental work it was recognized that there was a real need for the development of some preliminary test, the results of which would enable one to learn whether or not a person was especially radiosensitive, and in this way to assist in estimating the therapeutic dose to administer to this individual. Such a test, by demonstrating the general radium reactions of a patient, might be of value in prognosticating the effects of subsequent radium treatment.

We will consider the radiation transmitted by filters of zero and 0.16 mm. of brass to be principally beta radiation, and that filtered through 1.0 and 2.0 mm. of brass to be gamma radiation. For doses equivalent to each other as nearly as could be determined, no differences were noted in the reactions occurring within each group.

On the basis of our observations we have noted that the beta rays cause (1) a promptly visible primary erythema, (2) a transitory primary erythema, lasting one or two days, followed by (3) a period of days or weeks during which time the skin appears normal, (4) a visible secondary erythema which appears at the same time as does the secondary erythema of the gamma radiation, but which is of slight intensity and of short duration, and leaves the skin of a normal texture and but moderately pigmented.

The gamma radiation results in (1) a primary erythema which appears usually on the second to fourth day after irradiation and persists for about a week, (2) a secondary erythema which usually appears during the fourth week and which may progress to bleb formation. This is followed by a bronzing, which when marked, persists for many months. Of course the reason for this seemingly more severe gamma secondary reaction is that a considerably greater depth of tissue is involved than is the case after exposure to the less penetrating beta rays.

The points of similarity therefore are (1) that the primary erythemata are alike qualitatively, and (2) that the secondary erythemata appear at the same time after treatment.

The points of difference are (1) that the beta primary reaction usually appears sooner after irradiation than does the gamma primary. (2) The beta primary disappears in a shorter time. (3) The beta secondary is not so severe a reaction, and is followed by less pigmentation. In addition, the gamma primary reaction appears less frequently than the beta primary, and this seems to have no fixed relation to the appearance of a subsequent secondary reaction or to its intensity.

Therefore, in our attempt to obtain data from which to formulate a test for simplifying and rendering more accurate the therapeutic administration of radiation, we have only a few possibilities as indicated in the foregoing summary. Such a test must be easy to perform. It should require so little time that the usual turnover of the hospital beds is not greatly retarded, and most important of all, it should be accurate enough to indicate within narrow limits the amount of radiation that the patient will tolerate. It should enable the intensity of the reaction to be predicted for both the patient's skin and the patient's tumor.

It is seen that the beta primary reaction has practically no differential value. Though it appears promptly, it does so with too great regularity, has almost the same intensity in all cases, and remains visible in all individuals for about the same period of time.

The beta secondary appears much later, and in addition possesses the same general faults as the beta primary, and is no better than the gamma secondary. The gamma primary, on the other hand, is too variable. Frequently it does not appear at all. It is often so faint as to be questionable, and this even when the dose is correct for the patient, as shown by the subsequent appearance of the secondary reaction. The gamma secondary possesses some very real value. It seems to be a better test of the patient's reaction. Furthermore, it records the reaction to the type of radiation of most frequent clinical usage. It may be accurate for all practical requirements, but it entails a period of observation of approximately a month. This is a real disadvantage. Other draw-backs to the routine use of this test are (1) the labor and time consumed, and (2) the use of radium for a purpose other than that of actual therapy.

It probably will be granted that these obstacles would be ignored provided the tests proved of sufficient value. For this reason it may be of interest to record the comprison between the results of our skin tests and those obtained by the therapeutic applications to the same patients.

The skin tests on these cases were made with the erythema doses as in Table I. The radium therapy was applied in accordance with the best usage by clinicians of different divisions of the hospital staff, and the patients represented many types of tumor growth. We may surmise *a priori* that those patients who showed visible skin reaction to the erythema dose might also respond favorably to therapeutic radiation, and those patients who gave negative skin tests might likewise fail to improve clinically after radiation treatment. In any case, if we found a definite relationship between the observed effects of the skin tests and the therapeutic results of radiation, we could conclude that a suitable skin test would have a prognostic value.

Many possible factors of error are evident in attempting such a comparison, but with the patients chosen at random, and many types of tumors represented in all stages of development, and with more than 200 cases compared, a deduction may fairly be drawn, especially if the evidence is predominately in one direction. Clinical improvement was based upon the condition of the patient at least six months after treatment.

To simplify these analyses, two main divisions were made, namely (1) those which showed the secondary erythema, and (2) those which failed to respond to the skin tests with this reaction. Then the patients of each of these divisions were further classified according to whether (*a*) they responded favorably to the radium or *x*-ray applied therapeutically, or (*b*) they were not benefited by the treatment. In Division 1 it was found that of the patients who responded to the skin tests by developing visible secondary erythema, the ratio of benefited cases to those not helped was as 6:1.

In Division 2, consisting of those patients who failed to respond to the skin test by a secondary erythema, the ratio of the benefited cases to those not helped was as 1:11. These figures would seem to indicate that there is a relationship between the response of the skin to radiation and the effect of radiation upon a tumor in the same person.

The cause of this relationship may be some constitutional factor; and during the progress of the experiments notes were made concerning variability in reaction to radiation because of age, sex, complexion, personal idiosyncrasy, etc.

It was clearly shown that the young react to smaller doses than do adults and that the same doses cause a greater reaction in youth than in later years. Our records show that after sixteen years of age adult doses may be given. In senility the percentage of secondary reactions to the skin test was very low, and few of these senile individuals were benefited by radium therapy.

Sex variation seemed a negligible factor in our tests.

We obtained little if any quantitative difference in the skin tests because of complexion. The brunettes, however, reacted with a bronzing of the skin, especially after the secondary erythema, which was largely lacking in the blonds. In some white-haired individuals it was learned from the skin pigmentation whether they had previously been light or dark.

Regarding personal idiosyncrasy, it may be said that nothing has been noted that might not otherwise be explained. The writer gravely doubts its existence. However, one factor appears as most important in explaining cases of suspected idiosyncrasy, and this is the quality of the blood.

While it was impossible in this work to get perfectly normal individuals it was noticed that invariably weak reactions to radiation occurred in the anemic persons, and correspondingly strong reactions were associated with high hemoglobin and red blood-cell count. One case may be mentioned as illustrative of this relationship:

A well-nourished patient of normal body weight had had recent severe hemorrhage until his hemoglobin was 40 per cent and his red blood-cell count was 2,000,000 per cu. mm. He received the usual erythema dose of both bare and filtered radiation to the forearms. No visible reaction of any kind followed. Six weeks later some improvement in the general condition had occurred, and the same skin dosage was reapplied to other skin areas of the forearms. This test proceeded through all the stages of visible reactions at the usual time intervals. In addition, the areas first treated began to show very faint erythemata followed by faint tanning, which developed into a distinct bronzing during the course of about three weeks. On the day that the erythema appeared as the result of the first skin application, the hemoglobin had risen to 60 per cent, and the red blood-cell count to 3,200,000.

The somewhat fewer cases of emaciation with normal blood pictures reacted normally and readily to our skin tests.

Therefore in the search for a radiation test which might be performed easily, and would give an indication in a short space of time, we have failed, because while the secondary erythema from gamma radiation furnished such an indication, and in these tests was closely related to the therapeutic results, the period of observation is too long for its adoption as a routine procedure. Where the delay of a month is of little moment, it may well be employed.

On the other hand, the relationship between our skin tests, the therapeutic results, and the patient's blood quality has been so close as to warrant prediction of the effects of therapy within certain limits on the basis of this latter factor alone. This does not imply, by any means, that all patients with blood of good quality will be cured of their tumors, but it is valuable enough to prompt us to withhold treatment in certain cases and consider the patients as unsuitable for radium therapy until this factor either improves or has definitely failed to improve under a suitable regime, which might include blood transfusion. These statements should not be interpreted as in any way discouraging the use of radium to check hemorrhage, or simply as a palliation. Nevertheless it is believed that the results attending its use even for these purposes will be most discouraging when the blood quality is found to be poor.

Of course the blood count and hemoglobin estimation are at present a part of the routine examination in most hospitals, and the application of this test to the problem of the radiation treatment of any given individual causes no delay in his treatment, nor does it interfere with the activity of the hospital.

CONCLUSIONS

1. A method is described whereby skin erythema produced by radiation can be used as a standard of comparison, free from the usual subjective errors.

2. Using this as an objective biological indicator, the effect of filtration on radium radiation was determined.

3. The results (Table I) show in what proportion the millicurie-hour doses must be varied to produce the standard erythema with brass filters varying from zero to two millimeters. The millicurie-hour doses of Table I are for a distance of two centimeters. For any other distance they will be different but they will maintain the same relative values.

4. Having used skin erythema as a biological indicator, the results are directly applicable to skin dosage in radium therapy.

5. The determinations were made empirically, since no other method is available at the present time. The results, therefore, are not dependent upon any assumed correspondence between physical measurements and biological effects.

6. In attempting to formulate a skin test the result of which would enable us to treat the patients more accurately, we found that the secondary reaction to gamma radiation, when the erythema dose was applied, was closely associated with the subsequent therapeutic result. This finding was borne out in over 200 cases and for many varieties of tumor.

7. Among those patients who reacted with a skin erythema to the test application of radium, and received radium therapy, examination of the records at least six months afterward showed 6 benefited to 1 unimproved. Likewise, considering the class of negative skin tests, or those patients who failed to respond to the test application by the formation of a visible gamma secondary reaction, the number of those not benefited by radium therapy was greater than those who were improved in the proportion of 11:1.

8. It was found that the reactions to the radium skin tests were intimately associated with the quality of the blood of the patients tested. Those with normal or nearly normal blood reacted readily to the skin erythema dosage, while anemic individuals either failed to respond entirely, or reacted faintly and atypically.

9. The association between the positive skin test and favorable blood findings has been so close throughout these experiments that we believe the latter factor to be of the greatest prognostic value. On the basis of our results the patients with a normal or nearly normal blood picture, other factors

being equal, will be benefited or cured by radium therapy, while the anemic individuals will fail to show such a favorable response to the same treatment. We therefore recommend the routine blood examination of each cancer patient, both before radium treatment and during the course of observation, with the idea of maintaining a high hemoglobin content and red blood-cell count, so that the most favorable reactions possible may result from our radiation therapy.

In conclusion the author wishes to thank Mr. G. Failla for having suggested the problem and Mrs. Edith Quimby for her cooperation in making the tests.

WILHELM CONRAD ROENTGEN: IN MEMORIAM*

BY F. HAENISCH, M.D.

HAMBURG, GERMANY

THE German Roentgen Ray Society convenes, at its fourteenth meeting, for the first time outside of Berlin. The choice fell upon Munich. Our hope that this meeting would be distinguished by the presence of our most illustrious honorary member has been set at naught by the sad coincidence that the city where we now meet is the place of the death of the man to whom we all owe our gratitude. So it is a necessary and sacred duty to precede the business of the day by a brief memorial for our distinguished dead.

Wilhelm Conrad Roentgen is no longer among the living. On the 10th of February of this year passed one of the greatest discoverers and men of learning of all time. On the 13th of February a small select group paid him the last honors.

Roentgen was born March 27, 1845, in the little town of Lennepp in the mountainous region of the lower Rhine. His youth was spent in Holland. At the end of his studies in Zurich, in 1869, he was graduated from the technical college. As assistant of the physicist Kundt he came, in 1870, to Würzburg and in 1872 went with his professor to Strassburg, where, in 1874, he became a lecturer in the University. In 1875 he was called to a professorship in the agricultural college in Hohenheim and in 1876 returned to Strassburg as extraordinary professor. In 1880 he was called to Giessen as professor; in 1888, to Würzburg; since 1900 he had worked here in Munich, where in 1919 he retired from teaching.

In December, 1895, in the Physical-Medical Society of Würzburg, Roentgen presented his first epoch-making communication, "On a new kind of ray," which was followed on January 23, 1896, by the demonstration of further practical applications; this meeting closed with the making of the now famous plate of the hand of Geheimrat von Kölliker. On March 9, 1896, and May 13, 1897, two further communications appeared, to develop the epochal contents of which remained for the circle of roentgenologists. The astonishing fact is appreciated everywhere that Roentgen, in these three fundamental works, recognized almost completely the physical properties of the roentgen rays and in concise, accurate and exhaustive fashion described them; so that with all due respect to the value of the great number of physical works of many investigators, the great discovery by Laue of the wave nature of the roentgen rays has been the only important addition in a decade and a half.

The effect of these three communications on the whole civilized world was overwhelming. The surpassing greatness of his scientific deed lies in that Roentgen was the only one of the many experimenters who not only saw, but comprehended correctly, the empirical discovery, pursued it further and added to it; that he recognized that the observed manifestations were due, not to the cathode rays, but to a new and unknown kind of rays. That accident came to his aid, in no manner diminishes the greatness of his immortal work; only ill-natured envy could make such a criticism. On the contrary, in the ability to interpret correctly the accidents which are never lacking when there are great discoveries, lies the greatness of the surpassing investigator.

---

*Presidential Address Delivered before THE GERMAN ROENTGEN RAY SOCIETY, April 16, 1923. Translated from the German manuscript.

But Roentgen not only exhaustively set forth, in his first works, the physical properties of these rays: and even predicted their relation to light rays, he had the vision of the epochal development which his discovery would bring about in medical science.

The further development of medical roentgenology, for which he had furnished the firm foundation, he left, with his modest reserve, to the medical men, who in turn because of the rapid extension and the lively progress of the method very soon called in the help of physicists and technical men, men of science and of the industries.

His great reserve and his antipathy toward acclaim repeatedly kept him from accepting invitations to honor our annual congresses, which early became the center of roentgenologic science and technique.

To speak in this forum of the comprehensive scope and the practical significance of roentgenology on its present plane seems to be superfluous. You all, ladies and gentlemen, are practical working witnesses that there is no branch of medicine or surgery that has not recognized the aid of the rays and made them serve its needs, in either diagnostic or therapeutic application.

Not only practical medicine, dentistry and veterinary medicine have made unforeseen progress through the extension of the discovery, but also the theoretical branches, anatomy, pathologic anatomy, embryology, physiology, biology, etc., have adopted roentgen rays with constantly increasing interest and profit.

In our enthusiasm, however, we medical men must guard as rigorously against a false, one-sided overestimate of the value of our diagnostic adjunct as against a summary subordination of it by a preconceived clinical opinion. An uncritical estimate of the roentgen findings, divorced from the results of the clinical examination, or a reading into it of things which the roentgenogram cannot show, involve a greater risk and more severe consequences than the entire omission of the roentgen examination. The roentgenogram is always correct, but it is not always interpreted correctly; more is demanded of it than should be. The roentgenologic demonstration of a pathologic process may fail, but to exclude such a process on this ground would be, in many cases, an error. In the ability to recognize its possibilities, still often narrowly limited, lies the art of the roentgenologist. A pathologic change may be shown in a roentgenogram, yet herein alone lies no proof that it is identical with the anatomical basis for the patient's complaint.

We can thank the great benefactor of suffering humanity no better than to strive to employ rightly the instrument he has given us, and that is not always easy. Roentgenoscopy and roentgenography compose no *pons asinorum* of medical diagnosis. Medical art and diagnostic development are not decreased by it, but on the contrary, enriched. Also, "nil nocere" must remain in the development of every technique the supreme medical watchword.

Notwithstanding the diligent work of unnumbered practitioners, investigators and scholars, the world awaits still further application and clarification in almost every province of medicine, physics, and technical use, and further progress in scientific and practical application. Despite the restraint which the world war and the revolution with its catastrophic consequences have placed upon the development of every kind of culture, we see in our province a fresh scientific effort and energy to which this present Congress may bear witness.

Medicine is not the only debtor to Roentgen's discovery for mighty strides. Innumerable other branches of natural science have taken the roentgen rays into their service: zoology and botany, paleontology and anthropology, even the graphic arts; but above all, chemistry, mineralogy and crystallography. Many problems of crystal-structure and molecular investigation must be studied completely anew with the aid of the roentgen rays; and the systematic investigation of the elements has acquired, through roentgenologic spectroscopy, an entirely new foundation.

Discoveries of such overwhelming importance have been rare in the history of science. Roentgen's deed and name will forever remain with those at the pinnacle of the greatest of all time.

We medical men know our Roentgen and estimate him and his greatness from *our* viewpoint and on account of the great discovery by which he has benefited *us*, while many of us are unaware of his tremendous importance in the realm of physics, aside from the discovery which almost overshadowed his other achievements. Many of us learned first from the memorial address of his successor to the Munich chair, Geheimrat Wien, that his other physical works alone would entitle him to a place among the greatest physicists of all time: works and discoveries which were of fundamental bearing upon the theory of electro-magnetics, and even upon the theory of relativity. Geheimrat Wien emphasized the absolute reliability, the rigor of proof, and the exactness of expression which distinguished Roentgen's productions from all others, and designated him as the best classicist in the exact sciences.

Other honors, well-deserved, were not withheld from Roentgen. In 1896 he was made an honor citizen of his native town. In the same year he received the Rumford medal of the Royal Society of London, and in 1900 the Barnard medal of Columbia University and the Nobel Prize for physics. He was an honorary member of our society, and of innumerable medical societies which bore his name. He was a member of the Prussian and Bavarian Academies of Science, a knight of high orders, and was elevated to the nobility and given the title of Excellency.

We hear of Roentgen's remarkable personal characteristics which have been but little known, of the high lights of his character, chief among which were uprightness, love of truth, self-criticism and modesty. He kept at his research with a pure idealism and never accepted material gain from the fruits of his labors.[1] The greater the fame he attained, the more retiring he became. His greatest satisfaction was the assurance that he had conferred upon humanity an imperishable blessing.

We physicians and natural scientists, and with us the whole of humanity, are eternally indebted to this greatest of the great. To our gratitude attaches still one thing without which it would be incomplete. In the memorable meeting of January 23, 1896, the venerable anatomist, von Kölliker, proposed to name the so-called *x*-rays after their discoverer. The proposal found unanimous approval. It should be to us a sacred duty to preserve the name of the immortal discoverer for all time, and to protect this nomenclature from indifference, and above all, from the ill-will of hostile foreign countries, in which attempts have been made to discontinue the name of the German discoverer.

While the designation "radiology" may be correct for the terminology of the science of rays, it should be impossible to speak of anything in relation to roentgen rays except in words carrying Roentgen's name; and terms such as "radiography" or "*x*-rays" should be proscribed.

I beg of you in token of your lasting gratitude and your respect, to rise. Let us in this hour of commemoration take the solemn vow that we shall strive to administer and protect Roentgen's legacy as he would have it.

---

[1] In a personal communication, Dr. Haenisch corrects the statement in the April number of the JOURNAL, that Roentgen died in poverty in the house of a friend: "Roentgen was not rich, for he absolutely refused to accept any financial or material advantages through his invention, but he lived in normal circumstances, after retiring from his professorship in 1919, in a village suburb of Munich."

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-FOURTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

CHICAGO, ILL., SEPTEMBER 18, 19, 20, 21, 1923

Headquarters, Meetings and Exhibits: Congress Hotel, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY

TWENTY-FOURTH ANNUAL MEETING PRELIMINARY PROGRAM

The preliminary program which is published herewith indicates that the forthcoming meeting in Chicago will be of such a character as to make it a memorable one, and it is hoped that not only members but all others who are interested in roentgenology will make an effort to be in attendance.

CALDWELL LECTURE

Brown, Dr. Percy. (On the question of medical education and its relation to roentgenology.) Title to be announced.

FOREIGN CONTRIBUTORS TO BE PRESENT

Costa, Prof. Calatayud, Madrid.
Knox, Dr. Robert, England.
Friedrich, Prof. Walter, Germany.
Bucky, Dr. Gustav, Germany.
Hodges, Dr. Paul C., China.

PAPERS ON THERAPY AND THERAPEUTIC RESEARCH

Knox, Dr. Robert, England. "Some Aspects of the Cancer Problem."

Friedrich, Prof. Walter, Freiburg, Germany. Title to be announced.

Bachem, Dr. Albert, Chicago, Ill. "Radium and Roentgen Rays as Different Agents in Superficial and Deep Therapy."

Evans, Dr. Wm. A., and Leucutia, T., Detroit, Mich. "Deep Roentgen-Therapy of Neoplastic Pulmonary Metastases."

Ullman, Dr. Henry, Santa Barbara, Calif. Title to be announced.

Gerber, Dr. I., Providence, R. I. "A Review of Therapy as Seen on the Continent."

Drs. Falconer, Ernest, Morris, Laird H., and Ruggles, Howard E., San Francisco, Calif. "The Effect of Roentgen Rays on Bone Marrow."

Goosmann, Dr. Charles, Cincinnati, Ohio. "Technique of High Voltage *X*-Ray (Combined with Radium)."

Steele, Dr. Geo. H., Oshkosh, Wis. Therapy of tuberculosis.

Beck, Dr. Emil, Chicago, Ill. "Cancer Therapy from the Surgeon's Standpoint."

Pfahler, Dr. G. E., Philadelphia, Pa. "Measurements of Four Different Types of High Voltgge *X*-Ray Machines by the Duane Method and the Friedrich Iontoquantimeter."

Martin, Dr. Chas. L., Dallas, Texas. "Roentgen Cachexia."

Williams, Dr. John G., Brooklyn, N. Y. "The *X*-Ray Treatment of Fibroids of the Uterus and Uterine Bleeding not due to Malignancy."

Portis, Dr. Sydney, Chicago, Ill., and Arens, Dr. Robert, Chicago. "The Effects of the Shorter Wave-Length Therapy on Gastric Secretion of Dogs."

Pirie, Dr. A. H., Montreal, Can. "The Platinocyanide Pastille in Deep *X*-Ray Therapy."

Lawrence, Dr. W. S., Memphis, Tenn. "High Voltage Treatment in a Series of Sarcoma Cases."

Dunham, Dr. Kennon, Cincinnati, Ohio. "The Control of Hyperthyroidism."

Soiland, Dr. Albert, Los Angeles, Calif. "Evolution of *X*-Ray Therapy."

Case, Dr. James T., Battle Creek, Mich. Title to be announced.

Stevens, Dr. J. Thompson, Montclair, N. J. "Technique and Statistics in the Treatment of Superficial and Accessible Malignancy with Radium, Roentgen Rays, and Electrothermic Coagulation."

PAPERS ON DIAGNOSIS

Spangler, Dr. Davis, Dallas, Texas. "The Value of *X*-Rays in the Diagnosis of Atypical Pregnancies, with Report of Two Cases of Anencephaly Diagnosed Before Birth."

Doub, Dr. Howard P., Detroit, Mich. "Organic Hour-Glass Contracture of the Stomach with Some Reference to the Surgical Treatment."

Hickey, Dr. P. M., Ann Arbor, Mich. "Multiple Osteomyelitis."

Cathcart, Dr. J. W., El Paso, Texas. "Bone Dystrophies of Smallpox."

Hollis E Potter

PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY
1923-1924

Frontispiece, August, 1923
The American Journal of Roentgenology
& Radium Therapy

Nichols, Dr. Bernard M., Cleveland, Ohio. "Hydronephrosis."

Moore, Dr. A. B., Rochester, Minn. Title to be announced.

Moore, Dr. C. N., Schenectady, N. Y. (General Elec. Co.). "Data on New Water-Cooled Tube."

Mills, Dr. R. Walter, St. Louis, Mo. "*X*-Ray Evidence of Colonic Secondary Reactions."

George, Dr. Arial W., Boston, Mass. Title to be announced.

Green, Dr. J. H., Rochester, N. Y. "An *X*-Ray Study of 1500 Children Before and After Tonsillectomy Under Ether."

Bowman, Dr. Wm. B., Los Angeles, Calif. "Back Injuries."

Koenig, Dr. E. C., Buffalo, N. Y. "The Upper Left Quadrant."

Grier, Dr. G. W., Pittsburgh, Pa. "*X*-Ray Study of the Thymus Gland."

LeWald, Dr. L. T., New York, N. Y. "Lateral Roentgenography in Pulmonary Abscess."

Jenkinson, Dr. E. L., Chicago, Ill. "Carcinoma of Gastrointestinal Tract Accompanied by Bone Metastases."

Phemister, Dr. P. B., Chicago, Ill. "Differences in Destruction of Cartilage in Tuberculous and Pyogenic Arthritis."

Sante, Dr. L. R., St. Louis, Mo. "Tuberculous Lobar Pneumonia."

Skinner, Dr. E. H., Kansas City, Mo. "Observations upon Opaque Residues in the Colon: Report of one case Harboring one Opaque Meal in the Colon for Five Weeks."

Tyler, Dr. A. F., Omaha, Neb. "Dental Pathology as Revealed by the *X*-Ray Examination and Underlying Principle of Treatment."

Stewart, Dr. W. H., New York, N. Y. "Some of the Pitfalls in the Roentgenographic Diagnosis of Colonic Lesions with Suggestions as to the Proper Method of Overcoming Same."

Blaine, Dr. E. S., Chicago, Ill. "Healed Miliary Tuberculosis of Lungs."

Bassler, Dr. Anthony, New York, N. Y. "Is Haudeck's Niche as Diagnostic of Ulcer as Believed?"

OFFICERS OF NEW ENGLAND SOCIETY

At its last meeting, the New England Roentgen Ray Society elected for its officers for the coming year the following: President, Dr. P. F. Butler, Boston, Mass. Vice-President, Dr. W. A. LaField, Bridgeport, Conn. Secretary & Treasurer, Dr. A. S. MacMillan, Boston, Mass. Member of Executive Committee, Dr. Geo. W. Holmes, Boston, Mass.

COMING MEETING OF THE ITALIAN SOCIETY FOR MEDICAL RADIOLOGY

The fifth congress of the Italian Society for Medical Radiology will take place at Palermo, October 18th to 21st inclusive. The program is announced as follows:

1. Address of welcome by the president of the society, Professor Gioacchino Scaduto.
2. Professor Rossi (Parma): Roentgen therapy of diseases of the skin.
3. Professor Gortan (Trieste): Pneumoradiography.
4. Professor Boidi Trotti (Torino): Radiographic diagnosis of the urinary system.
5. Scientific communications.

The secretary of the society is Dr. Salvatore Sgroi, to whom communications should be addressed at Via Alloro, 58—Palermo.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Abstract of Proceedings of the Fourteenth Session of the German Roentgen Ray Society, Munich, April 15–18, 1923.[1]

The meeting of the German Roentgen Ray Society occurred this year for the first time outside of Berlin and was coincident with the Congress of Internists in Vienna. Prominent in the work of the committees meeting on April 15th was the discussion of roentgen-ray injuries and protection against them. A manual of directions for their avoidance is to be issued, which will contain the statement of minimum demands for legal purposes. The executive committee decided to endeavor to obtain a ruling through a communication to the authorities, classing roentgen therapy with potent drugs (poisons) and preventing its unrestricted use; and further, to make it necessary for a license to be obtained to conduct a Roentgen institute.

In the great auditorium of the University Frauenklinik, the scientific convention opened on April 16 with a memorial address by the president, Professor Dr. Haenisch of Hamburg, in honor of the discoverer who died in February.

After greeting the guests, Haenisch opened the Congress (which was composed of 956 members) and the associated industrial exposition.

The first day was devoted to diagnosis, and was opened by a paper by Jehn of Munich, in collaboration with Sauerbruch, on the roentgenologic diagnosis of surgical disease of the lungs. The essayist submitted that two measures had made possible the development of surgery of the thorax: the pressure chamber which enables the thorax to be opened without immediate danger to life, and the exact roentgenologic diagnosis, which is so important for surgical procedure. In disease of the chest wall the roentgenologic examination often reveals otherwise unrecognizable involvement of the thoracic contents. The closed pneumothorax in all its forms and spontaneous pneumothorax are thoroughly investigated. The sharp relief of the lungs allows also the fruitful application of pneumothorax for diagnostic purposes. The movement of the lung in closed pneumothorax corresponds to the type for the normal lung, so long as there is negative pressure in the pleural space. In the perilous open pneumothorax the occurrence of paradoxical breathing, flapping of the mediastinum, etc., are easily recognized by roentgenoscopy. Especially impressive are the roentgen findings in pneumothorax with positive pressure. Characteristic of valvular pneumothorax as consequences of the increased pres sure are changes affecting the mediastinum and the diaphragm. Epidiaphragmatic, apical and mediastinal empyema, difficult of diagnosis, were first recognized with certainty by roentgen examination. Basal empyemas are differentiated from subphrenic abscesses by their border being concave toward the apex of the lung, while the border of the subphrenic abscess is convex. Also clinically obscure febrile cases are diagnosed by the roentgen examination which reveals a small empyema. The principal cause of a residual empyema cavity, namely, small bronchial fistulae, can often be recognized roentgenologically. In abscesses, stereoscopy is indispensable. If fever persists after operative treatment of abscesses and gangrene, clinical examination fails because of the depreciation of the significance of auscultatory and percussion phenomena from induration and scar-formation and bronchial fistulae. Here only the roentgen examination is of further aid. As operative procedure in the cavernous forms of bronchiectasis, pneumotomy is recommended; in the diffuse forms, pneumectomy; for phrenicotomy and thoracoplasty have brought but little improvement in bronchiectasis. On the other hand, thoracoplasty is recommended in unilateral cirrhotic tuberculous processes in the lung. The roentgen plate is of great significance in respect to indications for operation and determination of its extent; and it shows in the cases selected for operation, how the tuberculosis will heal; it shows the displacement of the diaphragm upward, and that of the mediastinum toward the diseased side. The rigidity of the thoracic cage hinders the healing process, which was first made possible by thoracoplasty. The roentgenologic studies of these occurrences have given the stimulus to an operative treatment of these secondary scolioses. The surgical treatment of pulmonary tuberculosis has been proved out upon 500 cases; the results were demonstrated upon plates and upon patients. In the discussion upon operative treatment of lung tumors, attention was called to the relative frequency of primary pulmonary carcinoma superimposed upon healing tuberculosis and bronchiectases demonstrated by the roentgenogram. Of 5 cases of primary lung tumor operated upon, one patient was living after five years and another after three. The difficult and not always risk-free procedure of esophagoscopy can in many cases be replaced by examination of the esophagus with a contrast meal. The roentgen examination often demonstrates tumors of the posterior mediastinum which give no clinical manifestations.

---

[1] Translated from a manuscript received through courtesy of Dr. Haenisch.

In the second paper, Küpferle of Freiburg gave an anatomical analysis of the roentgen picture in phthisis. With Graeff of Freiburg he has made roentgenologic-anatomic studies, by the use of a process of hardening the whole thorax and then making any desired number of frontal sections. This allowed topographic studies of the shadows appearing on the plate and of the phthisic foci lying at various depths in the lungs. The essayist demonstrated numerous instructive roentgen plates and the corresponding serial sections of the anatomic preparations, and showed how the often complicated shadows on the plates can be reduced to their individual components. The productive focus (granulation tissue) involves the acinus and shows on the plate fairly sharp, round to trifoliate flecks: the picture of productive-acinous-nodose phthisis. The exudative focus, on the other hand, quickly involves the lobule and on the plate has irregular borders. The third form, the indurative-cirrhotic tuberculosis, and the fourth form, the miliary tuberculosis, were clarified by the comparison of plates and serial sections.

Chaoul of Munich called attention, during the discussion of indications for thoracoplasty in pulmonary tuberculosis on the ground of roentgen findings, to the fact that the result of thoracoplastic operations is at times limited by the lack of resistance on the part of the mediastinum, so that the cavity cannot be collapsed.

Relative to the differential diagnosis of pulmonary tuberculosis, Fleischner of Vienna spoke of clinical pictures of hematogenous origin which simulate acute miliary tuberculosis, but which from their more favorable course bear a resemblance to ordinary chronic phthisis, in which the assumption that the inoculation of the blood-stream almost always leads to this fatally ending condition does not apply. These are the so-called secondary or early forms. The recognition of these forms is possible by the roentgenograms, and their differentiation from the plates of the tertiary stage is important.

Altschul of Prague discussed the roentgenologic and clinical aspects of primary tuberculosis. The primary complex of Ghon, occasioned by aerogenic infection, occurs in children and adults. Old as well as fresh primary foci are demonstrable by roentgenoscopy and roentgenography. Lymph-node changes depending on the location of the primary foci are, in many cases, to be traced as far as the paratracheal nodes. Altschul shows the different sites of the primary affection in the lungs, which may lie in the infraclavicular region and leave the apices free; oftener one finds several primary foci, even infiltrations and cavities. The clinical course of such cases was for the most part malign.

Peltason of Würzburg employs for the compression of the pulmonary apices for fluoroscopy and filming a spoon of soft wood, fashioned to fit the supraclavicular fossa, and with its border inlaid with a fine wire. Confusion of pathologic apical shadows with shadows of the soft parts, struma, etc., can thus be avoided. The plates of apices demonstrated showed perceptible increased illumination of the compressed field. Reimann of Berlin obtains the same result in another way, namely with Frick's instrument, a sort of forceps that presses upon the clavicular origins of the sternocleido muscles.

Kaeding of Bonn has observed anomalies of calcification in the anterior portion of the ribs in cases of pulmonary tuberculosis, and compares the unilateral decalcification with Sudeck's atrophy. In the discussion the suspicion was raised that this was an artefact due to the technique.

In the discussion on the theme of pulmonary tuberculosis, Romberg of Munich emphasized the value of the analytic anatomic diagnosis; he contradicted the opinion often heard, that the pulmonary processes are too complex to allow such differentiations. The classification into exudative and proliferative or productive and cirrhotic forms is to be preserved, with separation of the hematogenous disseminated exudative and disseminated proliferative forms. The differential diagnosis of pulmonary tuberculosis is absolutely necessary for surgical intervention and for roentgen radiation, as well as for tuberculin treatment. He emphasized the value of making plates of the apices and warns not to diagnose tuberculosis where there is nothing more than stasis or bronchopneumonia.

Haudeck of Vienna noted the often unfavorable prognosis of cases limited to one lobe; and von Dehn of Petrograd spoke of the difficulty of differential diagnosis between exudative tuberculosis, grippe and pneumonia.

The roentgenologic aspect of the dissemination of pneumokoniosis of miners has been studied by Böhme of Bochum. He shows that in the first decade of work in the mines no changes appear in the lungs; in the second, only exceptionally; but in the third decade they were found in 40 per cent of the cases. Most of them were light forms. The development of the disease seems also to depend upon the kind of coal and mineral mined.

Saupe of Dresden has made systematic investigations of the pulmonary disease of miners in Schneeberg in Erzgebirge, where for several centuries has been recognized the "miners' disease of the Erzbergers," which in 1879 was designated pulmonary cancer. Bismuth, arsenic and cobalt are mined there. The principal symptoms of the disease are dyspnea and bronchitis. The roentgenologic findings in particular are disseminated small opacities, stellate and honeycombed. Pneumokoniosis doubtless prepares the ground for carcinoma, for of 143 miners examined, 4 had tuberculosis, 17 had pneumokoniosis (the differentiation from tuberculosis was often difficult), and in 7 there was tumor or suspicion of tumor (twice a carcinoma of a lobe and five times an isolated tumor the size of a fist). Four autopsies confirmed the diagnosis of carcinoma. A definite form of carcinoma characteristic for the Schneeberg cases was not found. Thus there is a prevalence of pulmonary carcinoma in a definite occupational group, which is perhaps predisposed to by pneumokoniosis, while tuberculosis plays a slight rôle. Investigations upon the etiology are in progress.

Lorey of Hamburg exhibited roentgenograms of pulmonary tumors. Most of them were of primary carcinoma. They are not as rare as was formerly believed and are often recognizable to the practiced eye. The solid tumor-like growths are the most frequent, and consist almost always of epithelium from the main bronchi; accordingly they begin with the picture of a hilus tumor. In their further course they infiltrate one or more lobes and can cause difficulty in differentiation from tuberculosis and aneurism. Lymphangitic carcinosis is rare: the thickened hilus region fades out peripherally in smaller and smaller flecks. The third form, miliary carcinosis, Lorey has seen once; it is not to be distinguished from the picture of acute miliary tuberculosis.

Lange of Munich showed roentgen plates of tuberculous disease of the vertebrae, with intrathoracic burrowing abscesses unmarked by significant clinical findings.

Kraft of Vienna showed a unique case in which the roentgenogram suggested echinococcus or tumor of the lung, but which on autopsy showed only a small pulmonary embolus, so that the plate was to be explained only by an infarct following embolism.

Flaskamp of Erlangen has observed striped thick-walled shadowy structures in the lungs of women who have been treated frequently with roentgen rays for mammary carcinoma; he regards the cause as former disease of the lungs. Haudeck of Vienna has seen the like; but he regards it as an indication of carcinoma tissue that the radiation has repressed.

Especial interest was aroused by the cinematographic pictures of the heart, by Grödel of Frankfurt-on-Main. Ten to sixteen exposures per second were made; a cardiogram synchronous with the film checked the analysis of the separate phases of action.

Hermann of Subotica spoke on unilateral hilus pulsation. In many people, even when the heart is sound, fluoroscopy with a contracted diaphragm shows a left-sided hilus pulsation. This phenomenon is very often demonstrable, especially easy to see when the lymph-nodes are shrunken or calcified. The nodes and the hilus structures then show a movement synchronous with that of the heart, principally horizontal, seldom obliquely upward. The patients have either slight complaints or none. The pulsation appears principally to the left, but is often present to the right. It is of significance that an anorganic systolic murmur is demonstrable, synchronous with the roentgenologically demonstrated hilus pulsation. Hermann believes that there is a genetic relation between the two, which, however, is to be worked out only by extensive pathologic-anatomic, roentgenologic and clinical investigations.

The communications on diseases of the stomach began with a roentgenologic and anatomic contribution to the knowledge of gastroptosis, by von Dehn of Petrograd, who observed that motor manifestations of irritability of the ptosed stomach often disappear on manual reposition. He attributes the manifestation to vagus irritation by dragging. Since he has been able to demonstrate plentiful smooth muscle fibers in the suspensory bands of the stomach, he regards the bands as capable of active contraction. Atony of the muscular elements in the suspensory bands can lead to a functional gastroptosis, which can lead to vagus disturbances.

Levy-Dorn has observed paradoxical gastric and intestinal function. He found the most diverse forms in one patient at four examinations at long intervals: at one time marked ptosis with ulcer symptoms, then the caudal pole at the level of the iliac crests and step-like indentations of the corpus ventriculi; several weeks later, marked cascade stomach with four-hour retention. On section, no pathology of the stomach was found, but there were old typhoid scars in the ileum. The condition, as had already been diagnosed, was a reflex neurosis. Careful interpretation of the roentgen findings is especially necessary in sick and frail people, for the organs are unduly susceptible to external influences. In such a patient the stomach was nearly full after four hours; a pyloric stenosis was diagnosed, which section failed to confirm.

Rieder of Munich discussed the anatomic

and roentgenologic differentiation between jejunum and ileum. The jejunal loops run more horizontally and show great numbers of Kerkring's folds; the ideal loops run more vertically, and show filling of adjacent loops, and a band-like form of the loops. Rieder demonstrated a small sterilizable cassette, with which he is able to identify a loop of intestine delivered through an operative wound.[1]

Dessecker of Frankfurt-on-Main reported an epidiaphragmatic diverticulum the size of a small apple, 40 cm. from the teeth. The operation is dangerous, but without operation the prognosis is absolute.

In the discussion Haudeck of Vienna spoke critically on the diagnosis of ptosis, and warned against confusing spastic hour-glass with typical ptosis shadows. In order not to lead the clinician away from other diagnoses, he does not make a diagnosis of atony on roentgen findings. Schreiber is of the opinion that clinical and roentgenologic findings can speak for ulcer, when the condition is only spastic gastroptosis. The complaint is readily explained by raising the stomach in front of the screen; when the stomach is raised, the pain disappears. Weinstein of Berlin described a frequent anomaly of the descending part of the duodenum: course bent over to the right. Adhesions have been shown to be the cause.

Köhler of Wiesbaden exhibited plates showing calcification of the radial and ulnar arteries of a nine-months-old child with Mongolism.

The roentgen diagnosis of the gall-bladder was discussed with lively interest. Teschendorf of Königsberg recommends the inflation of the duodenum through the duodenal sound introduced through the nose, until the patient feels distended; simultaneously administering a thick suspension of barium. Ulcer must be excluded beforehand. The inflation of the transverse colon with air he found of no aid, as in only a certain number of cases does it lie at the border of the liver.

Haenisch of Hamburg, encouraged by the American literature, has renewed his efforts on the roentgen diagnosis of gall-stones and the pathological gall-bladder. The technique is very exact and requires the making of many exposures, as well as experience and training of the eye. The procedure deserves further adoption, for when it is rightly employed it shows results worthy of notice. The demonstration of the pathologic gall-bladder is especially to be sought. Exposures with and without inflation of the colon give direct indications, examination with the Rieder meal give indirect. Instructive prints were shown, with unmistakable enlarged gall-bladder shadows, in which in some cases cholesterin gall-stones were indicated by spots of decreased density, and were later confirmed by operation.

Eisler of Vienna spoke upon the finding of transitory filling of the cap, which he regards as significant for the recognition of gall-bladder adhesions and changes in the duodenal wall.

Martius of Bonn described a simple method of measuring the pelvis. The patient is seated upon the table, with the upper body bent backward, so that the plane of the pelvic inlet lies parallel to the plate. The tube is centered over the middle of the pelvic inlet 60 cm. from the plate. The magnification varies with the distance of the symphysis from the plate; this is between 10 and 14 cm. The magnification is easily determined by a fenestrated rule (Drüner). One obtains not only the true conjugate, but also a true picture of the pelvic inlet. The method can be used with any sufficiently powerful machine without requiring expensive accessories; it is applicable even at the end of pregnancy.

Grashey of Münich demonstrated as an unusual roentgen finding a marked calcification of the Achilles tendon. He also reported a case in which a duck bone had been swallowed; the bone cast no shadow on a thorax plate. At autopsy the bone was found. It was rayed and cast only a faint shadow. This experience has made him cautious in drawing conclusions from negative findings in cases of suspected foreign body.

The luxation of the whole half of the pelvis in a ten-year-old girl who had been run over and dragged by an automobile was demonstrated by Levy-Dorn of Berlin. Haenisch of Hamburg mentioned a similar case which went for three months without diagnosis and was regarded as hysteria.

Levy-Dorn has demonstrated trichinosis *in situ* in the muscle of living patients. In a case which was confirmed by microscopic examination, there was slight granulation of the shadow of the muscle of the upper arm.

Seyerlein of Würzburg has studied the traumatic epiphyseal separations and their sequelae. The end-results of these not so uncommon fractures may be: (1) recovery (2) shortening of the whole member (3) partial disturbance of growth: in bilateral injury, shortening of the one and bowing of the other; in unilateral injury, angulation of the joint, when the separation involves only a part of the epiphyseal line (4) deformity of the joint of the hip, e. g., coxa vara, coxa valga (5) arthritis deformans (6) ankylosis.

---

[1] A less roundabout method of identifying portions of the intestine has long been available to American surgeons through the work of G. H. Monks of Boston, who has shown that the mesentery of the upper jejunum is translucent and contains a more simple system of blood-vessels supplying the gut; while in the lower ileum the mesentery is opaque from an increased amount of fat, and the vascular system is more complicated, the arteries breaking up into secondary and even tertiary loops before they reach the gut-wall. (See Monks' "Intestinal Localization," *J. Am. M. Assn.*, 1909, lii, 1079; also *Ann. Surg.*, Oct., 1903, and Oct., 1905.)

Vogt of Tübingen demonstrated numerous roentgen plates of malformations (the examination has the great advantage that the specimen is not destroyed): Thoracopagus, prosthoracopagus, cephalothoracopagus, chondrodystrophy, acephalus, acephalus with inclusion, micromelia, malformations of the extremities.

Lorey of Hamburg showed a case illustrating the disappearance of the niche shadow. A walnut-sized convexity was found on the lesser curvature; but after eight weeks of ulcer diet the niche had disappeared. Thus it could not have been a penetrating ulcer with walls thickened by connective tissue. The ulcer must have penetrated the mucous membrane and the mucosa, so that the intragastric pressure bulged out the serosa. These pulsion-niches, in contradistinction to the penetrating niches, are healable. The contour of the pulsion-niche, unlike that of the penetrating niche, is quite smooth; also, it has no gas-bubble. Haudek of Vienna believes that in such cases apparent healing occurs; according to his experience the niche returns when the spasm returns. Lorey had in addition a case of periarthritis coxae, analogous to the periarthritis humero-scapularis described by Haenisch, with bean-sized calcification above the neck of the femur. A further case of Lorey's was of congenital syphilis in a child eight months old with a negative Wassermann; the plate showed luetic periostitis ossificans involving both femora and humeri. Antisyphilitic treatment was begun and during this treatment a control plate showed, two months later, typical osteochondritis luica on the distal ends of the forearm and the leg. Furthermore Lorey has observed spontaneous healing of osteitis tuberculosa multiplex in a child, and that without treatment and under not exactly favorable hygienic conditions. Lorey questions, therefore, the significance of such therapeutic measures as tuberculin, etc.

On the second day of the Congress, roentgen therapy was discussed. De la Camp of Freiburg opened with a communication on roentgen therapy of phthisis. He holds that the therapy of pulmonary tuberculosis is furthered:

1. By recognition of the diverse forms of its origin.
2. By knowledge of immuno-biological matters.
3. By constitutional considerations.

Clinical experience and animal experimentation show that healing depends upon the natural resistance of the body; roentgen therapy must keep this in view. Since breaking down of the lung tissue is dangerous and leads to cavity formation, radiation is suitable only for non-progressive cases, or cases of nodose phthisis with contraction of the lung, which incline toward latency. With these limitations, roentgen therapy is not superfluous; in no other way, except by immuno-biological measures, can a dosable energy be applied to the disease focus. As regards dosage, M. Fraenkel's dictum is to be kept in mind, that a pathologic cell-complex has its own modus of reaction. An attempt to designate a uniform dose is to be warned against. Each case must have a mild, stimulating dose, not a destructive dose. When one has dosed too heavily, the temperature goes up and the weight goes down. The results of application of a roentgen dose to the spleen are little understood, since we know not a thing about the function of the normal spleen. Therefore our knowledge of the results of radiation of the spleen is based upon hypothesis and empiricism. The bearing of this is that in radiation of the lungs, we also radiate the spleen and the blood. Radiation of the spleen in case of phthisic hemoptysis is usually contraindicated because of difficulty in transportation of the patient and the brief duration of the effect. Small cavities are no contraindication; but roentgen therapy after artificial pneumothorax is contraindicated because it may bring about an exudative pleuritis. Also, the employment of roentgen therapy together with tuberculin is generally contraindicated because of the simultaneous effects. Yet this holds promise for the future, in analogy with the synergistic action of drugs. As for technique, a symmetrical generalized radiation is sought. The essayist gives five fields anteriorly and five posteriorly, each 10 × 10 to 15 cm., with a skin-focus distance of 30 cm. and a filter of 1 mm. of copper. The dose is $^1{}_{10}$ of a single skin dose, or 10 to 14 "e" by Friedrich's scale; increasing to a maximum of $^1{}_5$ of a single skin dose; 1 to 2 fields a week. If this disturbs the well-being of the patient, the dose is reduced and the intervals lengthened. The series may be repeated in two to three months. Radiation of ambulant cases is strongly advised against, but the delegates were invited to contribute to this subject, for further foundation for the knowledge of the subject is much needed.

In the discussion, Baemeister of St. Blasien showed numerous plates of chests before and after treatment by radiation, with marked effect in some cases. Even great cavities contract in a short time. Kästle of Munich observed that cavities can often be surrounded by a circle of granulation tissue. Fever-free patients without cavities and with not too extensive, productive lesions can be submitted to ambulant radiant treatment, in his opinion. Bucky of Berlin has radiated the exudative forms in children, with beautiful results; and children without tuberculosis but suffering from severe general asthenia, were made considerably better by the treatment. Hessmann of Berlin has had similar good results with children; he uses 1/5 to 1/3 of the single skin dose, at a skin-focus distance of 35 cm., filtering through 8 to 10 mm. of aluminum. Caspari of Frankfurt-on-Main has had interesting results from experiments on mice. The radiated mice lived longer, but had more extensive tuberculosis than the controls. In closing, de la Camp warned again against radiating the exudative forms even in children.

Great interest was roused by the contribution of Holzknecht of Vienna, on "How do the roentgen rays produce their effect?" and the discussion which followed. Holzknecht stated that our knowledge of the working of the roentgen rays is slight at most, but that a comprehension of the associated effects is necessary, in order not to be led again along false ways: as for example, the teachings as to carcinoma and sarcoma dosage, which are false. The uniformity of effect, which most remedies show, is due to a uniform mechanism and will lead to a uniform explanation of the roentgen effect. The intensive deep therapy gives the impression of an overestimated idea. One finds individualization everywhere in the pharmacopeia; shall the mere amount of the remedy explain only roentgen therapy? When one understands the subject of paralyzing doses and stimulating doses, one recognizes, since he is radiating normal and pathologic tissue, that he produces four different effects. The Arndt-Schulz law[1] cannot be considered to apply to roentgen therapy. Holzknecht departs from the idea of the stimulant effect of radiation; the supposed stimulant effect is explained on other grounds.

Pordes of Vienna sought to answer experimentally the question: Is the conception of a functional- or growth-stimulation necessary for explanation of the effect of the roentgen ray? He comes to the conclusion that the growth-stimulus of radiated plant seeds is only an apparent one, for later there is a retardation of development of the radiated plants. The radiation effect hitherto known as the stimulation effect is now understandable as a simple depression of function. Experimentally produced growth-stimulus thus represents damage; the Arndt-Schulz law is not applicable generally.

Mühlmann of Stettin furnished a clinical contribution on stimulant roentgen radiation. In severe secondary and pernicious anemias, radiation of the bone-marrow had a good effect in the greater part of the cases; the result shows in eight to ten days. In 3 cases treated clinically without result, roentgen radiation produced improvement; 18 per cent of the erythema dose was given. Good results followed mild radiation in nephritis with anuria; also in a case of nephrosis, diuresis appeared several hours after radiation.

Zweifel of Munich regards radiation of the spleen as indicated when medical treatment does not relieve uterine hemorrhages, on a chlorotic basis; in 40 per cent of his cases he obtained benefit.

Czepa of Vienna, speaking for Schwarz of Vienna, reported on a distinction that apparently follows a law, between benign and malignant growth in respect to its behavior toward roentgen rays. Benign tissue, for example, the hair papillae, responds to the same degree to equal or diminishing doses; but malignant tissue decreases in sensitivity to the ray, and becomes roentgen-fast; thus recidive tumors develop from less marked residual tumors. Czepa has radiated the fingernails in an attempt to get a stimulant effect, and in 13 cases has gotten the most diverse results, and regards this method as unsuitable for demonstration of the stimulant effect. In the further discussion, Vogt of Tübingen reported no dependable results in the constitutional hemorrhages of young girls nor in inoperable carcinoma, from radiation of the spleen. Opitz of Freiburg believes that the stimulant effect has not yet been observed in radiation of carcinoma; the stimulant-radiation of the ovaries produced the desired results in only a small proportion of cases; the problem, he believes, is very complicated. Holfelder of Frankfurt-on-Main recommended that all clinical and experimental observations be registered and that meanwhile, the expression "stimulation" (Reiz) be dispensed with. Haudeck of Vienna concurs that the Arndt-Schulz law does not apply to cellular processes. Wintz of Erlangen has observed that lighter doses diminish the sensitivity of sarcoma to radiation. The cases of stimulation must be collected; exact dosimetry is necessary for settling the subject. Christoph Müller of Munich explains the stimulant effect used as an argument against radiation, as due to damage to the already cachectic organism; Volhard of Halle, by the conception of an *indirect* growth-stimulus by injury to the surrounding cellular tissue. Voltz of Munich sees in the Arndt-Schulz law a very useful working hypothesis. Happel of Frankfurt-on-Main sees the roentgen effect as explained by Dessauer's "Punktwärme" theory. Von Seufert of Munich regards an insufficiency of the surrounding tissue as the cause of radiated carcinoma "running wild." Nürnberger of Hamburg found no evidence of actinodynamic change in the uterine mucous membrane of patients in whom the spleen had been radiated. In closing, Holzknecht emphasized that the physical and biologic aspects of the problem should not be divorced. The conception of a stimulant-effect has not been confirmed as a scientific fact.

---

[1] An account of the Arndt-Schulz law is given (*München. med. Wchnschr.*, 1922, lxix, 920) by Prof. K. Süpfle, from which it appears that in 1883 Rudolf Gottfried Arndt, a psychiatrist of Griefswald, made the following statement in his "Lehrbuch der Psychiatrie": "Weak stimuli kindle vital processes, medium accelerate them, strong inhibit them, and very strong destroy them." In 1887 Hugo Schulz, a pharmacologist, also of Griefswald but apparently working independently of Arndt, published similar conclusions in his work "Zur Lehre von der Arzneiwirkung." In 1892 Arndt brought out a monograph entitled "Biologische Studien: I. Das Biologische Grundgesetz" in which Schulz's conclusions are incorporated.

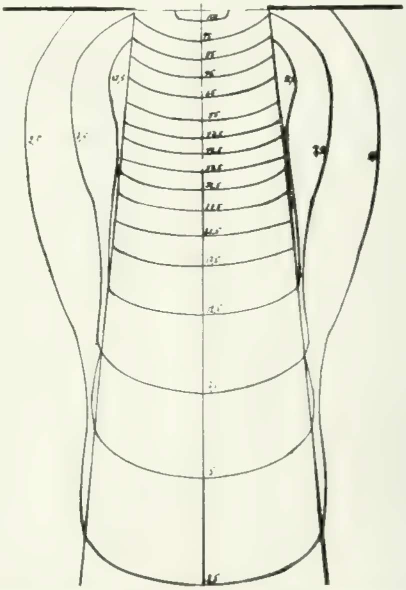
Theilhaber of Munich recommended, in his address on the electromagnetic waves and immunity, that multiple forms of this energy be combined (roentgen rays, diathermy, ultraviolet rays, etc.).

Strauss of Berlin has studied the influence of the roentgen rays on endocellular and metabolic processes. The literature on the effect of roentgen rays on cholesterin metabolism is wrong. The false conclusions result from a lack of method in experiment. He finds that the roentgen rays have a great effect on the cholesterin content of the blood. The "roentgen sickness" he regards as arising from the same cause. The radiation affects the hydrogen-ion concentration, as is demonstrable by the electrolytic method.

Sielmann of Munich spoke on roentgen therapy in Basedow's disease. Of 500 cases treated in the last ten years, he has followed up 328 within the last few weeks and found 50 per cent completely free from complaint and 44 per cent improved, while the surgical statistics show only 54 per cent of cases cured. The lesser danger speaks in favor of roentgen therapy, for the operation has 5 per cent mortality and can lead to paralysis of the recurrent laryngeal nerve and tetany. The essayist always radiates the thymus at the same time, and gives ⅓ to ½ of a single skin dose through 3 mm. of aluminum. It is of special significance that cases which were operated upon in vain were cured following radiation. Therefore one should first radiate, and operate only when radiation has failed. Pordes of Vienna recommends a mild radiation of a single field at first, to determine the tolerance.

According to Chaoul of Munich, lymphogranulomata in very cachectic patients are to be treated only with very mild radiation at frequent sittings, so as not to flood the system with catabolism products. Thus he gave a very sick patient 37 treatments, at each sitting only 10 per cent of the single skin dose. His 12 cases so treated have remained free from recidive for from seven months to three years. Nemenow of Petrograd added that the recidive of lymphogranuloma occurs usually in the peritoneal and retroperitoneal lymph-nodes and manifests itself at first only by temperature elevation and cachexia.

Haenisch of Hamburg presented a remarkable case of abnormally large lymphosarcoma, microscopically confirmed, which extended over the neck and chest, in which he began radiation with only two fields, single skin dose through .5 mm. of zinc and 3 mm. of aluminum, and in which, despite the complete regression of the tumors, there followed a severe cachexia. He does not recognize any standard dose for sarcoma or tuberculosis, and warns against beginning with intensive radiation, especially with mediastinal sarcoma, and advises strongly that a test radiation can be made on a few fields. Holzknecht recommends the most cautious dosage in Basedow's disease, lymphogranuloma, and leukemia.



Holfelder's curve of intensity of ray at varying depths.

Holfelder of Frankfurt-on-Main spoke upon the distribution of roentgen dosage in the depths of the body. He has experimented on the variation in intensity of the cone of the roentgen rays in a water-phantom. The experiments consisted (1) of direct observation and photometry of a zinc sulphite screen illuminated in water, and (2) of 50,000 measurements by means of the roentgen dose meter of Siemens and Halske. The great agreement of all the results proves an almost complete separation of the scattered radiation from the direct. Especially astonishing and of practical significance is the fact that the intensity of radiation at the edges of the cone of rays falls off very suddenly to a negligible minimum. The cone of rays is sharply preserved even in great depths, and is surrounded by only a very faint and practically negligible mantle of scattered radiation. In this respect the results obtained stand in abrupt contradiction of the isodosage curves of Dessauer and Vierheller, according to whom the intensity of a cone of roentgen rays is diffused on all sides. That the form of Dessauer's isodosage curves does not agree with the facts and that his tables give false values, any roentgenologist can confirm by placing an intensifying screen in a water-phantom and observing the cone of rays. The sharpness of the cone gives the dependable foundation for the flexible dosage system which Holfelder has worked out with the principle of selective fields. In the discussion Voltz of Munich recommended controls of the measurements of Dessauer and of Holfelder, which presented such a great discrepancy. At the instance of the president, a commission on roentgen therapy and physics was appointed.

Küstner of Göttingen spoke on the question of dosimetry. The purpose of measurement is the attainment of a known biologic effect. Our different measuring devices, for example even the leaf electroscope, satisfy only in part the demand for a uniform standard of measurement. They react differently to the different wave-lengths (degrees of hardness) of the roentgen rays (for example, photographic plates and ionization chambers). Large and small ionization chambers are not equally affected by different wave-lengths. Of foremost interest today is the question: What is the sensitivity of tissues, sound and diseased, to roentgen rays of different wave-lengths? In addition, there is much interest attached to the measurement of the true energy of roentgen rays of different wave-lengths. The question is now: Is the latter problem of the greater practical importance, or can the first be solved without the aid of the second? The answer is of importance inasmuch as the measurement of the energy is attended by great difficulties. With a given intensity and a given filter, the mixture of rays from our roentgen tubes is practically constant. It can be analyzed spectroscopically and the component parts measured with the ionization chamber. We know by this means, what ionization each wave-length of the ray-mixture produces. We now separate from the ray-mixture a wave-length interval as narrowly limited as possible, practically homogeneous, and thus work practically with a single wave-length, and we study simultaneously its biological effect and its ionization effect, and follow the experiments through with various wave-lengths; but we use the same chamber in every case, and indeed the same with which we have measured the ionization in the spectroscopic apparatus. In this way we employ the ionization chamber to determine for each wave-length of the mixture of rays a biologic effect corresponding to its intensity. We then know: With a given intensity and a given filter the biologic effect is this, with another intensity and another filter it is that, etc. We can thus determine the biologic effect of the different intensities with a given filter and in this way we can find out which mixture of rays is the most favorable for a given case.

We thus see that we can dispense with the energy measurement, that with a suitably constructed ionization chamber we can attain the same end, if we only employ the same example for the spectroscopic measurement and the monochromatic biologic measurements. Küstner seeks the construction of an ionization chamber which is of constant sensitivity and yet is so cheap that every roentgen therapeutist can avail himself of it. Just as a standard meter is provided for measurement of length, so should a standard model be provided for measurement of the strength of roentgen rays. Then it will be possible for different roentgenologic institutes to employ the same dosage. It was decided to entrust the working-out of these problems to a commission.

Sielmann, Jr., has investigated the influence of roentgen rays upon metabolism, and its bearing upon the therapy of roentgen sickness. After being rayed, dogs excreted more NaCl than was fed them. Sielmann regards as the cause of roentgen sickness, a damage to the protein metabolism and disturbance of the NaCl equilibrium, and recommends infusions of NaCl, which he found beneficial in 85 per cent of cases. For convenient use in practice there is the ready-to-use preparation "roentgenosan." The possibility of the application of roentgen rays in cases of deficient salt-excretion and deficient diuresis was mentioned.

Holitsch of Pest modifies the gynecologic deep therapy in that he uses the tube under the table with the patient on her back. This smoothes out the skin of the radiated surface, and furthermore gives a compression from the body-weight, with an approach of the uterus toward the skin surface of an average of 2 cm. in comparison with the ventral position. He has demonstrated the latter by comparative frontal exposures with a metal pessary in the uterus.

Winter of Munich spoke on his experience with the roentgen treatment of inoperable carcinoma of the uterus. He cites a number of apparently perfectly well women, who were radiated two to five years before because of inoperable carcinoma of the uterus. Of 197 cervical carcinomata, 50 per cent were recidive-free after one year, 24 per cent after three years, and 8 per cent after five years. He recommends that every carcinoma of the uterus that is not too far advanced should receive roentgen treatment.

Zweifel of Munich has had good results with the radiation of operable ovarian carcinomata three to four weeks after operation. By this combination he raised the percentage of cures to 50! Also in cases of residual carcinoma after operation in inoperable cases, radiation treatment offers hope of results. A case with incomplete operation remained well for eight years, with after-radiation with radium and roentgen rays.

At the end of the second day of the Congress a popular-scientific roentgen film was shown which was made at the instance of Doederlein in the Munich Frauenklinik under the scientific direction of Voltz. The animated film showed in impressive, instructive, and in parts amusing pictures, the revolution of the electrons in the Bohr model of the atom, the origin and the properties of roentgen rays, and the evolution of roentgen tubes and apparatus; in a second part will be shown the practical application of roentgen rays to various uses.

The third day of the Congress was devoted to technique and physics.

Glocker of Stuttgart opened with a paper on the application of roentgen rays to chemical analysis. The absorption bands resulting from placing a substance at the anticathode permit of qualitative analysis. A new application is quantitative determination of elements in chemical combination in solids and fluids, by measurement of the absorption-quality. Foreign substances in the mixture do not alter the result.

Stumpf of Munich has constructed a stereo-fluoroscope, using a diaphragm-box with two tubes which run simultaneously.[1] The rays are so diaphragmed that one tube illuminates only one-half of the screen, the second the other half, and the fields of rays decussate in only a small middle field. This construction is founded on the principle that one sees stereoscopically if one sees only a small part of an object binocularly. The apparatus allows exact depth-measurements.

Klingelfuss of Basel demonstrated a direct-reading spectrometer for roentgen rays. The hardness of the rays is read off in terms of wave-lengths. The sensitivity of the instrument is as great as that of a photometer for determining the shortest wave-lengths in a band-spectrum.

Schleussner of Frankfurt-on-Main has produced a new exposuremeter for roentgen exposures, the "Neo-Diskus," which takes into account the sensitivity of plates, double-coated films, roentgen paper, etc., and should be useful for beginners.

Chaoul of Munich exhibited a ray-condenser for small fields. It consists of a paraffin block 25 cm. × 25 cm. × 6 cm., with a central opening 6 × 8 cm. The intensity of the rays through the condenser was increased 40 per cent on the surface, 45 to 50 per cent in the depths. By radiating four fields, two anteriorly and two posteriorly, through 1 mm. of copper and at a distance of 30 cm., there can be delivered in the center of the abdomen 100 to 110 per cent of a single skin dose.

Heitz of Landau has substituted for the water-phantom a structure of paraffin-wax plates of the same absorption coefficient as water. It is more convenient to work with these plates than with a water-phantom. They are made of hard paraffin melting at 60°, with 20 per cent of wax added. Heitz also describes a practical method of insuring filtering, consisting in double hooks and also colored panes in the filter. The cable has a loop connecting with the hooks and cannot be connected with the tube except through the hooks.

Kraft of Dresden exhibited a photographic roentgen paper as a desirable substitute for films in the need of the time.

Cramer of Frankfurt-on-Main has had good results with sensitized "Neo-Papier" and recommends this paper above all for control exposures and for exposures of children.

Alfter and Gotthard of Munich spoke on spectrographic and iontoquantimetric measurements on roentgen apparatus. Kriser of Vienna has constructed an apparatus which by the use of an indicator which points out the central ray, allows radiation of the hypophysis with certainty. One may thus cover very small skin-fields; it is especially important, that one can easily radiate the hypophysis through infraorbital fields. He has also devised a lead capsule for the protection of one testicle while the other is being radiated. In the radiation of one ovary in fat women, to protect the other ovary from scattered rays he uses a lead vaginal septum which is pressed upon by a compressor in the midline above the symphysis.

---

[1] An attempt will be made to get a full description of this apparatus for a later number of the JOURNAL.

Beyerlein of Munich showed a new accessory apparatus for stereometric roentgenography.

Strauss of Vienna demonstrated the "Mekapion," a new measuring device for determining insulation and strength of rays. The working of this apparatus depends upon charging to a certain potential a condenser connected with the grid-circuit of an amplifying tube, which gives rise to periodical impulses of which the amplitude depends upon the amount of resistance parallel to the condenser. In this manner can be easily and exactly measured very high insulation resistances, and also the capacity and conductivity of fluids and gases and consequently the effect of ionizing rays.

Jaeger of Berlin has constructed a new roentgen dosimeter, which makes use of an ionization chamber and an amplifying tube. The dose is read off direct on the dial; at the end of the dose-period a bell rings.

At the end of the session Prof. Nemenow of Petrograd offered a resolution of fellowship in the name of the foreigners present from Holland, America, Bulgaria, China, Japan, Italy, Jugoslavia, Norway, Roumania, Switzerland, Russia, Spain, Turkey, Czekoslovakia and Hungary, expressing the pleasure felt over resumption of international scientific relations, and voicing the wish that German scientists may again be welcomed in other countries.

The president expressed gratitude for the spirit of the meeting and greeted the visitors in the name of the German Roentgen Ray Society, but observed that inasmuch as the international relations were suspended by those outside of Germany, resumption must naturally come from the same source.

Polak, John Osborn. Notes on the clinical value of radium in the management of uterine hemorrhage. *Med. Rec.*, Mar. 25, 1922, ci, 493.

The author gives a summary of the work done with radium in the clinic of the Long Island College Hospital. Its admitted use in cancer is granted. The author feels that it is only a matter of time when radium will replace operation.

In myopathic hemorrhages in young girls, sometimes obstinate to all forms of treatment, the endometrium becomes hypertrophied, and the uterus large and soft, the os tending to remain open. These cases were formerly treated surgically. Now the author applies radium in such a way as to establish a normal menstruation after one seance. Only once has he had occasion to repeat the exposure. In this class he treated 31 cases; the average dose was 400 mg. hours, and all but one of the cases received but one application. The last case, which required three applications, was followed by amenorrhoea for one year, after which normal menstruation was re-established. Six of these 31 girls are now married, and 2 have become pregnant.

Operation is still the procedure of choice for most myomata, for radium has certain disadvantages. Malignant complications may be easily overlooked, for it has been shown that sarcoma is found in serial section in about 9 per cent of submucous tumors. Fifty-four per cent of all fibroids are complicated with some form of tubo-ovarian disease. Radiation is not applicable in women who may yet bear children. Fibroids accompanied by pressure symptoms should be treated surgically. Irradiation will increase the necrosis of tumors which are already necrotic. On the other hand, should radium fail, operation is always possible. The menopausal symptoms are not so marked. There is no operative mortality and radium is the method of choice in myomata complicated by heart disease, extreme anemia, diabetes and chronic nephritis. When the tumors are larger than a four months' pregnancy the author prefers operation. One hundred and six cases have been treated by irradiation, the average dose being 2,000 to 3,000 mg.-hours. Only 2 have needed subsequent operation. In both these there were large submucous tumors, the bleeding recurred, and at operation it was found that the tumors had undergone a marked edema. In the remaining 104 cases the bleeding ceased and has never recurred after the first menstruation. In 80 of these cases the growth has shrunken to less than half the original size. In 20 it has entirely disappeared.

Another class of cases which may be relieved by radium application are the bleedings resulting from subinvolution and fibrosis of the uterus without lateral or posterior parametritis or a history of pelvic inflammation. Two hundred and sixty cases were treated in this class. There were no failures to check the bleeding. Several in this class which were associated with prolapse have subsequently been operated upon.

Case, James T. Pericarditis calculosa (report of a new case discovered roentgenologically). *J. Am. M. Assn.*, Jan. 27, 1923, lxxx, 236.

The author reports a new case of calcification of the pericardium discovered roentgenologically. This makes the twelfth case thus far reported in the literature in which a diagnosis was made during life. These were all made by means of the *x*-rays (Schwarz 2, Groedel 1, Rieder 2, Weil 1, Brauer 1, Assmann 1, Klason 2, and Mueller 1).

The author has reviewed the literature on the subject, giving the total number of cases found in the literature prior to 1922 as 90. It is significant that almost without exception the visceral and parietal layers of the pericardium are united by a plastic process, in which the calcareous deposit occurs. There is a total obliteration of the pericardial cavity. Impaired circulation is probably an important factor; other calcifying factors are decreased metabolism, necrobiosis and tissue necrosis. A number of the cases cited above give a history of pericarditis, pleurisy or some undermined "trouble" in the chest. It was only rarely, though, that a diagnosis of adherent pericardium was made during the life of the patient. The lime deposits occur especially over the anterior and inferior aspects of the ventricles, while the auricles are rarely affected.

The author thinks the process begins as a serofibrinous or fibrinous pericarditis. During the production of the reactive granulation tissue there is a reduction of the blood supply to the fibrinous masses, which, when not absorbed, may remain imprisoned for a long time. Such dead masses in which the circulation is very slow and insufficient have a decided tendency to undergo calcification (Klason). Naturally, the lime would accumulate in those regions of the pericardium subjected to the least disturbance from the contractions of the chambers of the heart.

The description of the calcareous deposits in a large number of cases was quoted verbatim from the literature.

From the roentgenologic standpoint the following may be suggested as signs of pericarditis adhesiva: (*a*) a triangular-shaped heart; (*b*) disappearance of the boundaries between the various heart chambers, usually made out fluoroscopically; (*c*) diminished excursion of the edge of the cardiac shadow during heart action, and (*d*) diminished mobility of the heart in relation to the diaphragm with the patient in the lateral positions.

The roentgenologic study of pericarditis calculosa should be carried out both with the screen and with plates. Several cases, finally discovered, went through repeated plate and screen study before the diagnosis was made.

Klason believes the fluoroscopic study more valuable than the roentgenographic. True, one can vary the penetration of the ray employed and can turn the patient in various directions more easily and economically with the screen than with the plate method. Case prefers a combination of screen and roentgenographic examination, though in the case reported in this paper he discovered the calcified pericardium while repeating a part of the barium meal study. Such a case impresses very forcibly the lesson that no fluoroscopic observation should ever be attempted until after the eyes have been thoroughly prepared for screen observations by a long preliminary stay in the dark.

BISHOP, LOUIS FAUGERES. Fluoroscope in the diagnosis of diseases of the heart. *Med. Rec.*, Mar. 25, 1922, ci, 489.

This is an article in which the author urges the value of the fluoroscopic examination of the heart, especially with reference to the fluoroscopic diagnosis of the activities of the different chambers of the heart and the probable auricular and valvular defects as well as the discovery of congenital lesions. The author ventures to assert that fluoroscopy will become a routine measure in every physician's office before very long. The author would rather forego the roentgenogram than the privilege of observing the heart in all its activities. He ventures to say that in the detection of minor impairments of the heart the fluoroscope is vastly superior to the stethoscope and when it is supplemented by the cardiograph at least 30 per cent of otherwise unknown conditions are added to the factors which must be considered. The mental process of discounting distortion of shadows due to the nearness of the tube in fluoroscopy is much easier than one would suppose. With reference to the normal heart the author believes there is really no such entity. The nearest approach can be found in a heart which is normal to the person carrying it. The heart of the laborer would be abnormal to a bookkeeper, for example. The one disappointing element in the subject of fluoroscopy of the heart is that the question of personal skill comes in and training of the observer is necessary. In cardiology nothing is more popular than the arithmetical formula, but so far it has usually failed to be useful.

JOSEPH. Death after pneumoperitoneum. *Berl. klin. Wchnschr.*, 1921, lviii, 1361.

Rautgenberg published his experiments with pneumoperitoneum for the first time in 1914. He and Goetze developed the method, and others have spoken very highly of its results. Mayer ascribes not only a diagnostic but a therapeutic value to it in the case of a patient with adhesions of the genital organs who had no further pain two weeks after the injection of air into the abdomen. He explained the fact by the assumption of a kind of massage exerted by the air. Kaestle has made similar observations.

But, strange to say, one hears little concerning the use of pneumoperitoneum from surgeons. The fact is that this method is really unsurgical. Even if resulting lesions seldom occur, they are possible, and one shrinks from piercing the abdomen for purely diagnostic reasons. Another explanation is that there are unfortunate results to match the good ones.

Benthin publishes such observations. These are limited to the small pelvis, where the method seems most unsatisfactory. A tumor that could be palpated was not visible by roentgen radiation. Another seemed visible, but was actually non-existent. Leschke tells of intestinal injury in a case of carcinomatous peritonitis. Others mention various forms of discomfort to the patient.

Biernath found air in the abdomen at operation after twelve days. In a case of ulcus duodeni the whole parietal peritoneum and omentum were filled with air bubbles. Death followed from subphrenic abscess and lung infarct.

The technique has lately been changed and is now very simple, as it has been proved that ordinary air causes no more infection than do oxygen and nitrogen. Some use the usual pneumothorax apparatus, others a needle, with the air forced through a water-bulb. Goetze places the patient with the pelvis raised, a subatmospheric pressure zone then arises in the pelvis and the bowels follow the law of gravitation. He believes that injury can be avoided in this way.

Pneumoperitoneum has been used in a few cases at the Moabite hospital. Unfortunately one death occurred, and the report of the case is interesting, as the cause of death lay not in the method but in an anatomical abnormality.

A woman of forty had a movable tumor below the right ribs, the size of a fist. A kidney tumor was diagnosed, but for greater certainty a roentgen diagnosis with pneumoperitoneum was decided on. A needle was introduced into the abdomen below the navel, with local anesthesia, and air driven in at low pressure by means of a double bellows. The air-bulb contained about 150 c.c. When it had been emptied twice the patient suddenly collapsed, with cyanosis and rapidly diminishing pulse, and died in a few seconds in spite of every possible measure. Immediately on collapse the air and the needle were removed from the abdomen.

There was no trace of blood on the needle, or anywhere else at section, nor was any injury to a vein macroscopically visible. At the same time the autopsy showed that death had resulted from air-embolism.

A suspicious spot was found in the vena iliaca, where an injury was visible under the microscope, but this could not be definitely related to the puncture of the abdomen.

The patient had a strong scoliosis of the lower vertebral section to the right; the promontorium reached very far down and formed a strongly projecting elbow, so that it lay directly under the abdominal wall when completely relaxed, but could not be felt because of the considerable adiposity.

This anatomical abnormality is the only explanation of the accident.

The purpose of this report is not to discourage the use of pneumoperitoneum, but to call attention to the fact that such anatomical conditions require special watchfulness and precaution, and may even be a contraindication to pneumoperitoneum.

Bailey, Harold, and Bagg, Halsey J. Effects of Irradiation on Fetal development, *Am. J. Obst. & Gynec.*, May, 1923, v, 461.

The authors deprecate the many loose statements concerning the cure by irradiation of gynecologic conditions during all periods of sexual life with the intimation that no serious results follow the treatment of these conditions. They deem it proper to present some clinical and experimental facts relating to the subject, especially in regard to the reaction of the ovary and the developing fetus. The experimental data upon the lower animals have shown that when the sex glands are sufficiently irradiated before fertilization the following are typical fetal reactions:

1. Disturbed, abnormal, arrested development, resulting in the formation of monsters conforming more or less to a general type, and pronounced disturbances in the development of the central nervous system (Bohn, Perthes, O. and G. Hertwig, Schaper, Tur, Bordier and Baldwin).
2. A marked tendency to a progressive loss of fertility.
3. A specific modification of the hereditary mechanism (Mavor) and the production of inherited defects in the young, especially in the eyes (Little and Bagg).

Irradiation during pregnancy produces the following typical disturbances in fetal development, depending upon the developmental period at which the irradiation is instituted:

1. Disturbed, arrested, abnormal development with death of the embryos, absorption or abortion, stunting in growth, cataract, sterility, lesions of the central nervous system and blood vascular disturbances in the embryos. (Hippel and Pagenstecher, Regaud, Nogier, and Lacas-

sagne, Lengfellner, Krukenberg, Cohn, Walter, Bagg, Hansen, and Lacassagne and Coutard.)

In a discussion of the clinical reports it must be borne in mind that the data cannot be presented with the same scientific evaluation that may be given to experimental biologic studies, and although one realizes that one cannot directly transfer the experimental results from animal to man, yet apparently there is no reason for considering human developmental processes as essentially different from those of other mammals. It has been the aim of the authors to bring together the clinical reports, to interpret and correlate them as much as possible, and to add 6 cases. The authors recognize that developmental disturbances are to be found in many instances of human ontogeny where irradiation has never been applied and they wish to caution those who contemplate the irradiation of women during the child-bearing period with a view to preserving the procreative ability.

In judging the clinical reports the authors believe that in those instances where comparatively great disturbances have resulted in the child, the irradiation was given early in pregnancy. They believe that irradiation during early pregnancy may produce death and abortions of the fetus. Irradiation during late pregnancy is not so likely to produce gross developmental abnormalities in the child at birth, but the clinical data seem to agree with the experimental in several instances where children irradiated in utero at this period have been prematurely delivered, or have shown postnatal growth disturbances, or death within the first year. Werner reported 3 such retarded children, and 4 that died during the first year.

The severity of the treatment, as well as the period in development when the irradiation was given, no doubt determines the reaction of the fetal tissues. The authors' third case was treated during the fifth month of pregnancy, and then only locally, an effect largely due to beta-ray radiation within the vulval tumor. At the eighth month the mother was treated over the vulva with gamma-ray radiation which was equivalent to 50 per cent of the skin dose. The treatment was not severe, the fetus was not directly irradiated, and the child was apparently normal at birth and has remained so to the present time.

The second division of this study relates to the irradiation of women before conception where complete sterility is not produced. The experimental evidence in the lower animals shows with great probability that irradiation injures the follicular elements of the ovary. The authors' first case was suffering from Hodgkin's disease and ten months before conception was heavily radiated with *x*-rays. A male infant was born with an extensive developmental arrest in the formation of the head, and died after a few hours. The second patient was irradiated for a fibroid with gamma-ray radiation both from within the outside the uterus, and she became pregnant eighteen months later. In this instance a large, stillborn infant was born at term. The authors' last case was also irradiated with a gamma-ray radiation from a platinum tube placed in the uterus. Conception occurred seven months later, and the child was apparently normal at birth. The evidence is not sufficient to warrant our attributing the developmental defect in the first case, or the stillbirth in the second as due to irradiation.

The authors therefore conclude that it is questionable whether radium or *x*-ray irradiation should be used to destroy the ripe follicles, leaving the immature ones injured but capable of development. This statement is made entirely on the strength of the experimental work on the lower animals, and they do not feel justified in considering any of the available clinical records as adding conclusive evidence in this regard. In the treatment of menorrhagia in the child-bearing period they believe that complete sterility is preferable to the possibility of a damaged germ plasm.

Irradiation of the ovum during early pregnancy should never be permitted. Radiation in late pregnancy, while it may not produce gross abnormalities at birth, may hinder the growth and development of the child in later life.

GRANGER, AMEDÉE. A new technique for the positive identification of the sphenoid sinus and the ethmoid cells. *J. Radiol.*, Apr. 1, 1923, iv, 105.

Without taking the space to review the previous work done in this field, the author reports his own experiments, which are fully illustrated in the article. The reproductions surely support his claim for adequate identification of the sphenoid sinus and the ethmoid cells. The success was due mainly to the use of a head-rest which he had previously designed. This head-rest consists of a sheet of bakelite, with a triangular hole cut for the nose, attached to a wooden frame $\frac{1}{2}$ in. high and about $\frac{3}{4}$ in. wide, the whole surrounded by a strip of wood $\frac{1}{4}$ in. thick and $\frac{1}{4}$ in. deep. By these means the bakelite sheet upon which the head will rest can be securely held over a film holder or cassette, and at the same time kept a distance of $\frac{1}{2}$ in. away. When the nose is placed in the hole cut out in the bakelite sheet—the size and position of this hole having been carefully determined—the head is automatically centered on the same part of the film, the soft tissues of the nose can be compressed without pain or discomfort, and what is much more important, the head now rests on the superior maxilla and the glabella. Two constant fixed points, varying little in heads of different sizes and shapes, now afford good firm support to the head, doing away entirely with the tendency to pivot either in the direction of its longitudinal or transverse diameter, a tendency always present when the nose is one of the two points on which the head rests.

The article needs reading to appreciate the numerous detailed points made by the author.

G. Gaertner. Death after pneumoperitoneum. *Berl. klin. Wchnschr.*, 1921, lviii, 1467.

(Remarks on an article by the same title by Dr. Joseph in No. 46 of this weekly.)

Some years ago the suggestion was made of filling the joints with oxygen for the purpose of roentgen transillumination. A surgeon simplified this method by using air. It succeeded a few times, then a patient died of air embolism. The author was reminded of this case on hearing of the plan of filling the peritoneal cavity with air in order to render its contents distinct before the roentgen rays.

The author proved in 1902 that large quantities of oxygen can be introduced into the veins of men and animals—several liters in men—without harming the organism. The gas is easily absorbed by the red corpuscles and never causes an embolism if the strength of the stream is not too great. This is not true of air, which causes certain death. On the author's suggestion the intravenous injection of oxygen has been successfully used to relieve sufferers from asphyxiation.

Since gas can enter the veins from a closed body cavity, only pure oxygen free from nitrogen or hydrogen should be used for the purpose:—never air.

An exception exists in the case of filling the pneumothorax with nitrogen. Perhaps the gases cannot penetrate the veins located there, because of pathological changes. Air, or still better, nitrogen should be used, as oxygen is too quickly absorbed.

The speed of the stream of oxygen must not be greater than the gas-absorbing capacity of the venous blood, or a fatal tamponade of the right side of the heart will result.

In using oxygen for pneumoperitoneum the injection should be slow and the heart continually ausculated. When the gas bubbles reach the left ventricle they make a loud splashing sound synchronized with the pulse. They do not indicate actual danger, but serve as a warning. The injection should cease, and some gas perhaps be drawn out again.

With the use of air or vapor the splashing sound indicates the greatest danger and immediate steps must be taken, not only precautionary ones, but the radical measures generally used in the case of air-embolism.

R. Rhule. Roentgenological studies concerning an alteration in the upper wall of the os innominatum known as the os acetabuli. *Arch. f. Orthop. etc.*, 1921, xix, 518.

The author has gathered together roentgenological material, together with clinical and autopsy reports, to prove that the small independent bony formation often seen in roentgenograms of the hip-joint, against the pubis and just above the head of the femur, is not the anatomical os acetabuli, and is miscalled when so designated by roentgenologists. He sums up his conclusions as follows:

1. The roentgenological os acetabulum is not identical with the anatomical os acetabulum, which is a constant pubic element.

2. The roentgenological os acetabulum is always to be considered as a pathological formation.

3. The roentgenological os acetabulum is usually the result of a rachitic, late rachitic, or osteomalacic disease of the bones.

4. In very unusual cases the roentgenological os acetabulum may be related to adults to a traumatic fracture, or it may be a tuberculous or osteomyelitic sequestrum of the upper acetabular margin, or a perior para-articular ossification, or a localized corpus mobile or a new bone formation.

5. In the case of late rachitis or its secondary diseases, the roentgenological os acetabulum is to be considered as a spontaneous infraction of a kind that causes mostly a general lightening of the bone shadow, or as a spontaneous fracture at a typical spot. The zone of illumination between the lateral bony segment and the pubis is probably a zone of transformation in Looser's sense, caused by a change of lamellar bone into uncalcareous, reticulous bone.

6. There is ground for the hypothesis that an upper acetabular margin extended into a spur as a result of rachitic alterations below the articular cartilage of the acetabulum (Fromme) plays a certain rôle in the formation of the roentgenological os acetabulum.

7. A knowledge of the roentgenological os acetabulum and of the possibilities as to its origin is of basic importance in accident surgery.

Enfield, Charles D. The scope of the roentgenologist's report. *J. Am. M. Assn.*, Apr. 7, 1923, lxxx, 999.

The author states that the ideal roentgen-ray report should present a careful and accurate description of the picture seen. It should offer whatever explanation of variations from the normal may be conservatively given on a basis of established roentgen pathology. It should give, when this can be conservatively done, an estimate of the activity and present importance of the lesion, such estimate, however, to be derived entirely from the roentgen signs. It should place in the hands of the clinician all the information the roentgenologist has been able to obtain by his peculiar method of examination and should offer it in such form as will most facilitate the correlation of the roentgen and clinical evidence.

In the course of his remarks, the author refers to some controversial points, particularly regarding the present attitude of the roentgenological fraternity toward roentgen-ray diagnosis of gall-bladder conditions. About gall-stone shadows there can, of course, be no question. If seen, they indicate with certainty the presence of gall-stones and, by inference, past or present gall-bladder disease. There are, however, two other types of positive roentgen-ray evidence with regard to the gall-bladder which have assumed steadily increasing importance during the last few years. First in point of time is the so-called indirect evidence of gall-bladder infection consisting in deformities of the duodenum, alterations in tone of the pyloric portion of the stomach, and fixation or other abnormality in the hepatic flexure of the colon. These phenomena are, of course, caused either by adhesions, resulting from inflammatory processes in the gall-bladder and ducts, or by reflex nervous disturbances originating in the same locality, or by both causes acting together. In their typical form they give a picture that is characteristic and convincing to a large proportion of roentgen-ray men. More recently, the effort to demonstrate the gall-bladder itself on the roentgen-ray film has somewhat overshadowed these indirect signs.

The author, in common with certain roentgen-ray workers, is extremely dubious about accepting the fact of a gall-bladder shadow as proof of gall-bladder disease. The whole point is one which will require much more work and a much larger series of operative checks to clear it up to everyone's satisfaction. In the meantime, reports of gall-bladder examinations in which the gall-bladder (but no stones) is shown, should indicate clearly that such a finding, while indicative of gall-bladder disease with or without stones, latent or active, does not by any means imply that surgical interference is called for on that basis alone.

Fay, Temple, and Grant, Francis C. Ventriculoscopy and intraventricular photography in internal hydrocephalus. *J. Am. M. Assn.*, Feb. 17, 1923, lxxx, 461.

The authors report some interesting observations relative to the appearance of the functioning ventricle in the living subject. An opening through the thinned cortex in the silent area of the brain was planned as being a far safer procedure than the more formidable midline approach between the hemispheres. Through this opening, a No. 12 operating cystoscope was inserted, affording a clear view of the ventricular walls.

The authors' conclusions are as follows: Intraventricular photography and ventriculoscopy are possible in the presence of dilated ventricles. Little or no reaction follows such procedure when properly conducted. The diagnostic value of direct inspection of the ventricular cavities may prove of considerable importance in determining the location and the extent of growth of subcortical lesions causing deformities of the ventricles. A satisfactory approach with regard to the area and extent of the opening desired may be made through a dilated ventricle in order to permit callosal puncture under direct observation. Photography for the purpose of reproducing the appearance of structures or lesions within the ventricles requires at least forty seconds' exposure.

In view of the interest created in ventriculoscopy by the work of Dandy and others, this paper is extremely interesting.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X SEPTEMBER, 1923 No. 9

OBSERVATIONS ON THE LATERAL POSITION AND OTHER METHODS OF EXAMINATION OF THE RENAL AND GALL-BLADDER AREAS

BY SIR JOHN THOMSON-WALKER, M.B., F.R.C.S.

AND

ROBERT KNOX, M.D., M.I.E.E.

LONDON, ENGLAND

THE current literature contains few references to the lateral position in the radiography of the kidney and gall-bladder. O'Brien[1] advocates the lateral view, and states that it may obviate the necessity of catheterization of the ureter. A shadow lying against the vertebral shadow may reasonably be stated to be due to a calculus in the kidney. Pfahler[2] suggests an oblique position to throw the shadow of a gall-stone outside that of the kidney shadow. The patient lies obliquely on his right side and the compressor is directed into the epigastric region and tilted so that the cylinder is resting posterior to the right costal border.

TECHNIQUE

In previous descriptions of the lateral position the patient was turned on his right side, and the *x*-rays passed from above either directly or obliquely. There are certain objections to this method. When the patient lies on his side, a varying degree of displacement of the organs under examination takes place. The kidney is especially affected by this change of position. It sinks forward and toward the middle line, and if the mobility of the organ is increased, as in movable kidney, the change in its relation to the vertebral bodies which form the fixed points of a lateral radiogram is considerable. And further, the relation of the kidney to other abdominal organs under examination also undergoes some change. On the other hand, perirenal adhesions will interfere in this position with what might be regarded as a normal variation in the position of the kidney. Moreover, the loss of time and the muscular effort made by the patient in assuming the lateral position may spoil a lateral pyelogram by emptying the renal pelvis.

Some part of the value of a lateral radiogram or pyelogram is the comparison with the anteroposterior view. It is important that both these views should be taken with the patient in the same position. For these reasons it is essential that the lateral negatives should be taken with the patient lying prone or supine, and the latter is the preferable position for the ordinary kidney negative.

Where pyelography is used, a rapid combined technique should be thought out and practiced by the surgeon and radiologist. The essentials in work of this kind are rapidity of action, shortness of exposure, and a tube of the degree of hardness best suited to the conditions under investigation. With a table of the description shown, it is possible to screen from below and take negatives from above and from the lateral aspect in a very short time, without in any way disturbing the patient. When catheterization of the ureter is required, the surgeon can readily get at the patient, and when the pelvis is injected, three or more negatives can be exposed in different positions, and the time employed need not exceed a few seconds for each exposure.

---

[1] O'Brien, F. W. The present status of gall-stone diagnosis by the roentgen ray. *Boston M. & S. J.*, 1916, clxxiv, 309.

[2] Pfahler, G. E. An improvement in the technique of gall-bladder diagnosis. AM. J. ROENTGENOL., May, 1915, ii, 774.

An important feature in the technique is the employment of the duplitized film with two intensifying screens, one on either side of the film. This combination diminishes the exposure necessary for the production of high-class negatives. In hardly any case need the exposure exceed two seconds, and the majority are made in one second or less. Coolidge tubes or gas tubes can be used. When the latter are employed, it is important not to pass too many discharges through the tube in quick succession, because of the heating effect. As a rule, the short exposure required for kidney and gall-bladder work is not likely to disturb seriously the vacuum, if care is taken to keep the tube in a suitable condition. In this the duplitized films and screens are a boon, and undoubtedly they are responsible for a great improvement in the quality of the negatives produced.

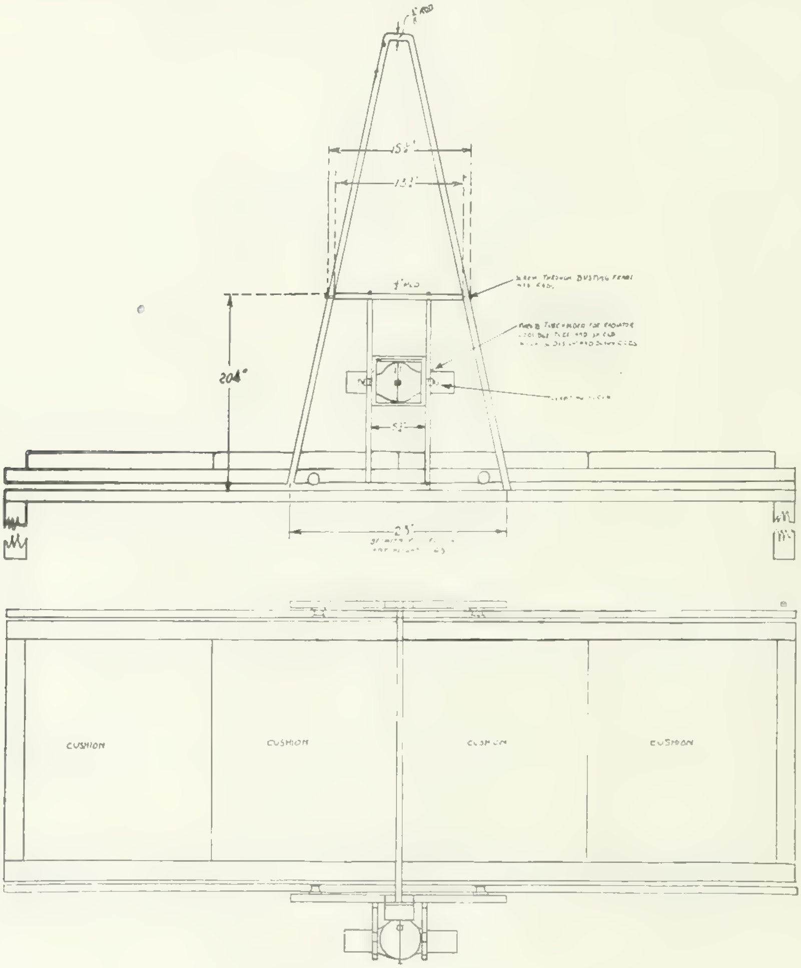


Fig. 1. Apparatus for lateral radiography.

Lateral radiography may be used alone or with the addition of an opaque catheter in the ureter, or of pyelography. A note may therefore be made in regard to the latter method of examination:

The best catheters in use in pyelography are those made in Paris. With care they may be sterilized by boiling. They are supple and retain a good surface, and the lumen compared with the total caliber is large, while they throw a heavy shadow.

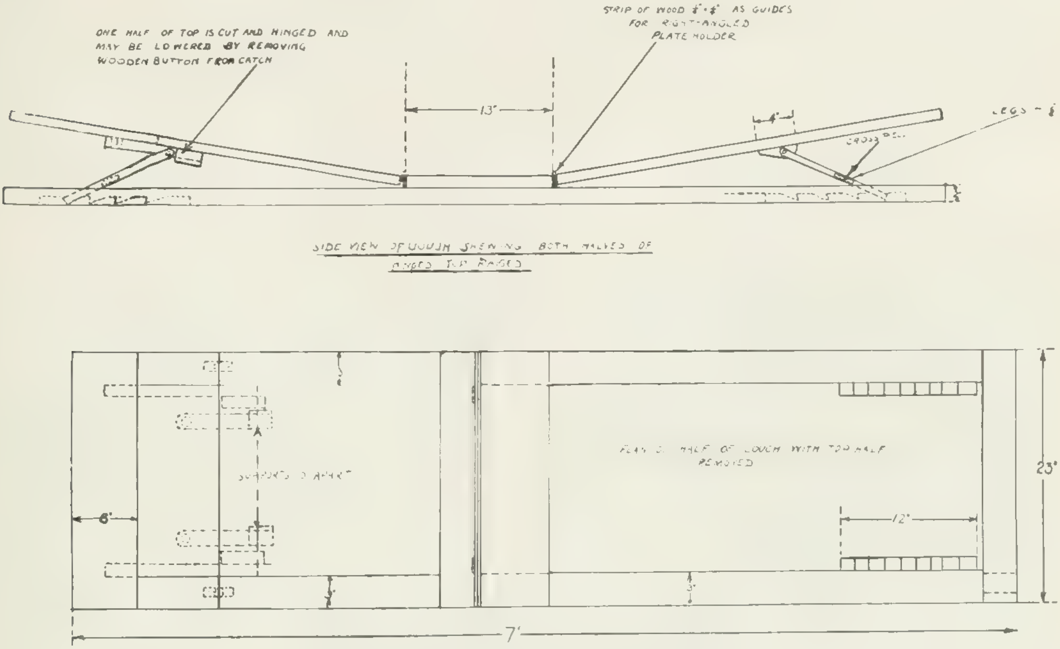

ONE HALF OF TOP IS CUT AND HINGED AND MAY BE LOWERED BY REMOVING WOODEN BUTTON FROM CATCH
STRIP OF WOOD AS GUIDES FOR RIGHT-ANGLED PLATE HOLDER
13"
4"
LEGS
SIDE VIEW OF COUCH SHEWING BOTH HALVES OF HINGED TOP RAISED
PLAN OF HALF OF COUCH WITH TOP HALF REMOVED
6"
12"
3"
23"
7'

Fig. 2. Table-top for lateral radiography.

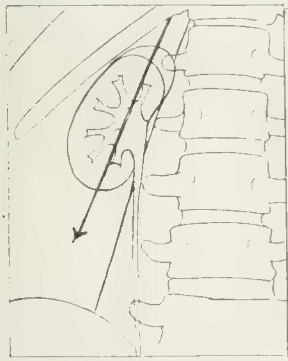


Fig. 3. Diagram showing normal position of kidney.

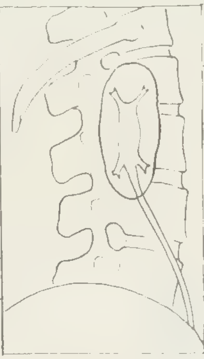


Fig. 4. Diagram showing position of kidney, renal pelvis and ureter in lateral view.

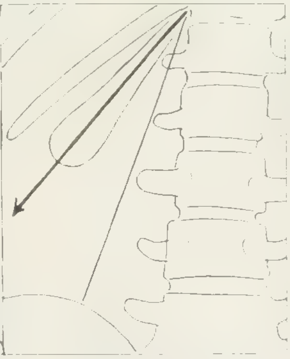


Fig. 5. Diagram showing position and axis of gall-bladder.

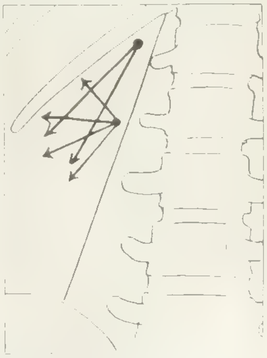


Fig. 6. Diagram of radiating lines of renal and biliary calculi.

The ureteric catheter is passed in the recumbent position. The catheter is marked in centimeters and the distance that it passes up the ureter should be carefully noted, as it disappears into the orifice. In the average patient 25 to 30 cm. is the usual length of catheter that disappears before it is arrested. The point of the catheter passes into the upper calyx in all cases where the ureter and pelvis are in the normal alignment, and where there is no dilatation of the pelvis. When a catheter with terminal eye is being used, it should be withdrawn ½ cm. Neglect of this precaution may lead to imperfect filling of the pelvis and the remaining calices, for the patient feels pain when the upper calyx is distended, and the operator is misled into believing that the pelvis is already full.

If it is desired to study the contour of the uretero-pelvic junction, the catheter should be withdrawn about 2 cm. after it has passed the full length and has been arrested. The opaque fluid shows the natural contour of the upper ureter and its relation to the pelvis, which the rigid catheter would otherwise modify to some degree. If the catheter is arrested in the ureter before reaching the renal pelvis it is still possible to inject the fluid and fill the renal pelvis. Very rarely obstruction at the uretero-pelvic junction will prevent the fluid passing into the renal pelvis, and it is returned alongside the catheter to the bladder.

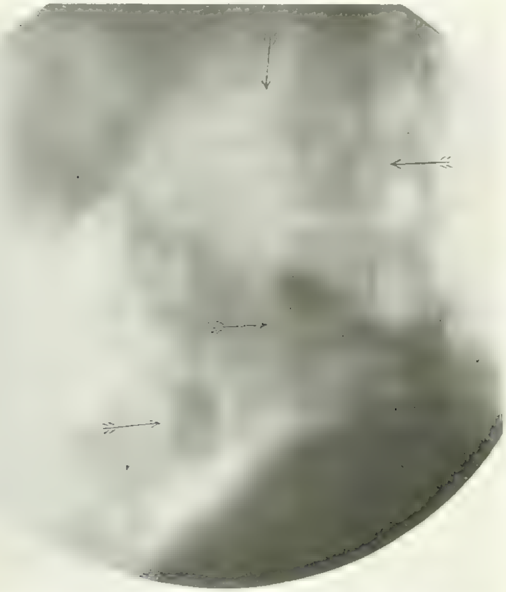


Fig. 7. Lateral pyelogram showing pelvis of kidney over shadow of body of second lumbar vertebra, opaque catheter in ureter, calcified glands in front of ureter and spine and gas-filled hepatic flexure of colon in front of renal pelvis.

Sodium bromide solution (20 per cent) introduced by Weld, has in our practice superceded other opaque fluids. It throws a shadow rather less dense than that thrown by collargol, but sufficiently heavy for all routine work. Sodium bromide is irritating to the bladder, and when it escapes down the catheter the first intimation will be an intense desire to pass water. In solutions stronger than 20 per cent it is irritating to the renal pelvis. The solution should be sterilized by boiling, and oxycyanide of mercury (1 in 8,000) added to keep it aseptic. It is an advantage to have it slightly warmed. After passing the catheter a glass syringe (20 c.c. capacity) is attached to it by means of a small rubber connection introduced by one of the writers.[1] The pelvis is now emptied of its contents by suction with the syringe. This is a necessary precaution, for if dilatation is present, a quantity of fluid is constantly retained in the dilated pelvis, and into this the opaque fluid is injected. This dilution of the opaque fluid produces a poor shadow. Before injecting the opaque fluid the film is placed in position and the tube adjusted. If compression is required this is applied now, so that no further manipulation is necessary, and no time is wasted after the renal pelvis is filled before making the exposure. The examination having been completed, the renal pelvis is at once emptied of its contents, by suction with the syringe. Should it be necessary to have the film developed and the catheter retained for further exposure, the pelvis is emptied by means of the syringe and the catheter allowed to remain in the ureter in the interval.

INTERPRETATION OF ANTEROPOSTERIOR AND LATERAL RADIOGRAMS OR PYELOGRAMS OF THE UPPER ABDOMEN

An accurate knowledge of the size, shape, position and relation of the organs in this region is necessary for the reading of the radiograms.[2]

The liver, gall-bladder and bile ducts, the kidney, renal pelvis and upper ureter, the suprarenal capsule, the pancreas and the pancreatic duct, the duodenum and hepatic flexure of the colon and certain abdominal lymphatic glands are all crowded into a comparatively small space, in the right side of the upper abdomen, and in a given case the symptoms and the radiographic findings may lead to a discussion in regard to the pathology of any of these organs. A few notes may therefore be made in regard to the organs more commonly concerned in obscure cases.

---

[1] Thomson-Walker, J. Renal Function in Urinary Surgery. London, 1907.

[2] Knox, R. Radiography in the Examination of the Liver, Gall-bladder and Bile Ducts. London, 1919.

The anatomical points upon which localization in an anteroposterior view of this region depends are the last two ribs, especially the twelfth rib, the bodies and transverse processes of the lumbar vertebrae, the crest of the ilium and the oblique outer margin of the psoas muscle. In the lateral view the ribs give no help except to mark the twelfth dorsal vertebra. The bodies of the lumbar vertebrae and the spines of these vertebrae are the anatomical structures by which localization is estimated in the lateral position. The iliac crest obscures some part of the field, but does not help in the localization.

In the anteroposterior position the kidney lies in the upper part of the space bounded by the twelfth rib, the outer border of the psoas muscle internally, and the crest of the ilium below. The long axis is obliquely set so that the inner border of the upper and lower poles closely approximates to the oblique line of the psoas muscle. The pelvis lies at the outer border of the psoas at the level of the transverse process of the second lumbar vertebra. From this the ureter passes downward on to the transverse processes of the third, fourth, and fifth lumbar vertebrae. This position is modified by respiration and by position. With full expiration the upper pole ascends behind the twelfth rib, and with full inspiration the kidney descends about half the breadth of a lumbar vertebral body. In the vertical position there is a similar descent of the kidney.

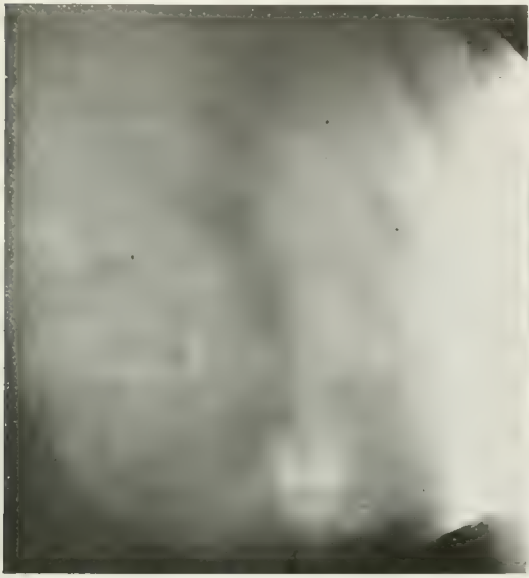


Fig. 8. Lateral skiagram of case of calculus in the common bile duct. A round dense shadow situated well in front of the vertebral body.

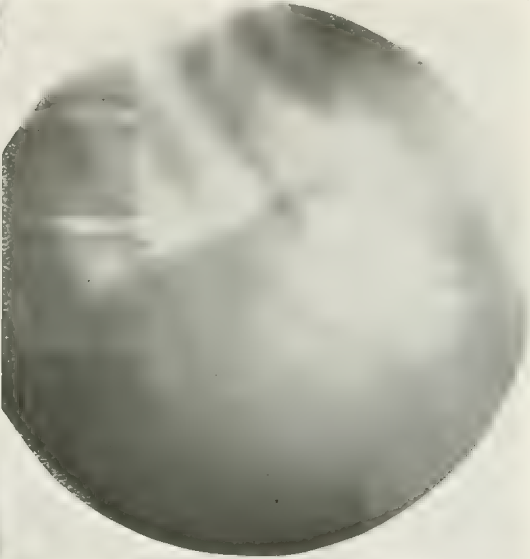


Fig. 9. Lateral view of stones free in gall-bladder.

The shadow of a normal kidney can be recognized in a radiogram of first quality. The lower pole and the inner border are most evident, and the upper pole less defined. A pyelogram shows the lumbar segment of the ureter, the pelvis of the kidney and the calices.

The ureter lies on the transverse processes of the fifth and the fourth lumbar vertebrae, and on the tip of the transverse process of the third lumbar vertebra. The pelvis is opposite the second lumbar transverse process external to the outer border of the psoas muscle.

In the normal pelvis and calices normally placed the following five points should be present.[1]

1. The pelvis is trumpet-shaped, the upper and inner margin being vertical or curving gradually outward, while the lower or outer margin curves outward on a small arc.

2. A catheter passed up the ureter will pass onward vertically or with a gentle outward curve to enter the upper calyx.

3. The calices seen in profile have a constricted neck and a terminal cup into which the apex of the pyramid projects. Seen in face either looking toward the plate or away from it a calyx appears as a round dark area with a lighter center. The calices seen in profile are more easily recognized than those in face.

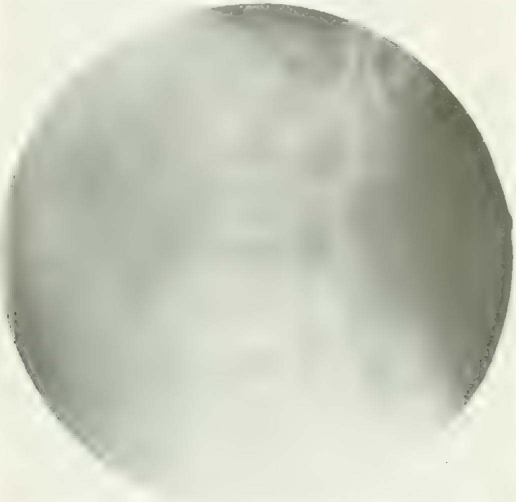


Fig. 10. Lateral view of gall-bladder with gall-stones in duct and detritus at fundus.

In some negatives all the calices are taken in profile. Usually one or two calices are seen in face. It may very rarely happen that all the calices are taken in face.

4. The outer border of the upper ureter, the lower border of the pelvis, and the inner border of the lowest calyx form a curve, the uretero-calicine curve, which amounts to half a circle. Pronounced changes in this curve are seen in dilatation of the pelvis and in the displacement of the kidney.

5. The ureter passes so gradually into the pelvis that no definite point can be distinguished as representing the ureteropelvic junction. Where the junction is marked by a sudden change of contour the condition is abnormal.

In the lateral view the kidney lies on the sides of the bodies of the first, second and upper part of the third lumbar vertebrae. Its shadow cannot, even in a radiogram of first quality, be defined. In a pyelogram with opaque catheter in the ureter, the pelvis and abdominal segment of the ureter are shown. The pelvis throws an elongated oval shadow tapering at its lower extremity and lying in the shadow of the body of the second lumbar vertebra. From this the shadows of the calices project to right and left, that is, anteriorly and posteriorly. The upper calices project above the shadow of the pelvis like horns, and the lower calices downward below the pelvis. The ureter passes downward and forward, crossing the body of the third lumbar vertebra, and reaching the line of the anterior border at the lower border of the third and the upper border of the fourth lumbar body.

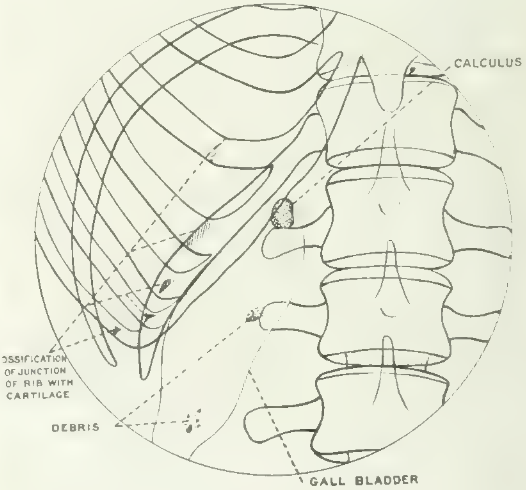


Fig. 11. Line drawing of gall-bladder showing stone at opening of cystic duct, drawn from the anteroposterior view of Figure 10.

The suprarenal capsule lies in the angle between the twelfth rib and the body of the first lumbar vertebra, but it may lie higher than this behind the twelfth rib or just above it.

---

[1] Thomson-Walker. J. *Cong. internat. Assn.*, Paris, 1921.

The normal gall-bladder has been demonstrated on several occasions. It should be the aim of all radiologists to show the lower border of the liver and any irregularity projecting below that border. If a normal gall-bladder is distended with bile, it should show a projecting bulge at the level of the ninth costal cartilage. The density may not be greater than that of the liver.

In the majority of pathological conditions affecting the gall-bladder, including biliary calculi, the accompanying cholocystitis leads to a thickening of the whole of the wall of the organ. This thickened wall will show in a skiagram which is of the proper quality.

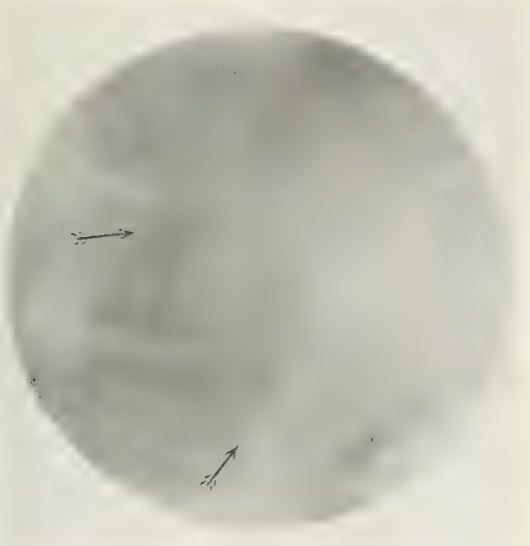


Fig. 12. Lateral view showing kidney stones on vertebral bodies and gall-stone anterior to spine and lower down.

Where the shadows of a collection of gall-stones are demonstrated, the shape of the organ may be distinguished. The position of the gall-bladder varies more than that of the kidney in different individuals. It may occupy the space between the twelfth rib and the outer border of the psoas muscle usually occupied by the kidney. The shadow is an elongated pear-shape with the apex above. It lies nearer to the twelfth rib than does the kidney shadow, and its long axis is not parallel to the outer border of the psoas muscle shadow, as in that of the kidney, but bisects the angle between the twelfth rib and the psoas. The space between the inner border of the pyriform gall-bladder shadow and the outer border of the psoas shadow is much greater than that between the kidney and the psoas. Very considerable variations are found in the relation of the gall-bladder to the bony landmarks, and this is not always due to the varying position of the gall-bladder, for the twelfth rib may be long and very oblique, so that the costovertebral angle is narrow. The gall-bladder shadow is then in relation to the twelfth rib and the last costal space. The long axis may be more vertical or more transverse. In the lateral view the gall-bladder lies anterior to the lumbar vertebrae and reaches as low as the third lumbar vertebra. These points ascertained by radiography are confirmed by a study of the anatomy of a cross-section of the body at this region.

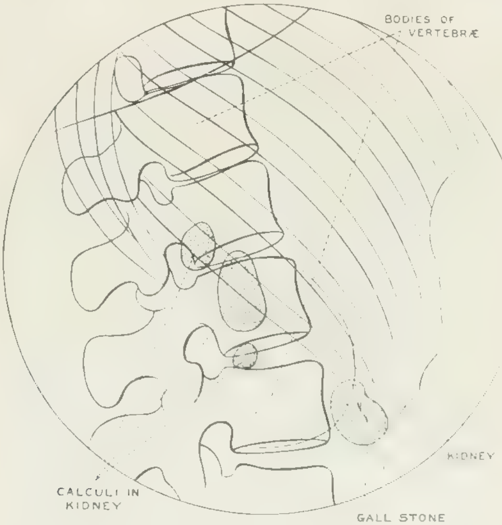


Fig. 13. Diagram of case shown in Figure 12.

VARIATIONS IN DISEASED CONDITIONS

While the preceding descriptions hold good for cases where little change has occurred in the size or position of the organs, some variations may be brought about by disease. The movable kidney has a wide excursion, and may be found partly below the iliac crest in the anteroposterior view. It should be noted that mobility of the kidney may change the relation of the organ to the vertebral bodies in lateral radiography. If a patient with a movable kidney is turned on the side, the organ falls forward, and a stone shadow may be thrown in front of the anterior margin of the bodies of the vertebrae. It is obvious, therefore, that the lateral view must be taken with the patient lying on his back in order to avoid this displacement.

When the kidney is greatly enlarged as in pyonephrosis, the organ rises out of the paravertebral hollow, and with the patient lying on the back, stone shadows in such a kidney may appear in front of the vertebral bodies in the lateral view. There is, however, little difficulty in diagnosis in such cases, for the kidney that has reached this size is readily palpable, and easily recognized.

The wall of the gall-bladder, which is the seat of chronic inflammation, is thickened, and frequently throws a shadow comparable in density to that of the kidney, so that the outline can be traced in the skiagrams. It does not follow, however, that where a definite shadow of the gall-bladder is shown the organ is necessarily pathological. A normal gall-bladder which is dilated with bile and projects well below the border of the liver, will be shown in a negative of good quality. Attention was first called to this point by the work of Leonard and George on "The Pathological Gall-bladder," and our experience confirms this observation. Failure to appreciate this important fact has led to the exploration of a normal gall-bladder under the mistaken impression that a defined gall-bladder shadow in a skiagram must indicate a pathological condition.

In order to attain familiarity with the possibilities of demonstrating the normal gall-bladder, a large number of negatives of this region should be carefully examined. It will then become apparent that the outline of the gall-bladder is shown in a considerable proportion of these.

The gall-bladder which contains gall-stones may be so enlarged as to project well below the level of the kidney in the anteroposterior view, and in the lateral, reaching as low as the middle of the body of the fourth lumbar vertebra. When greatly distended, it loses its pear shape and becomes more rounded, but it never assumes the shape and outline of the kidney. It may occupy practically the same area as the kidney, and if only the lower half of the gall-bladder shadow is seen it might easily be mistaken for the lower pole of the kidney.

In chronic cholecystitis adhesions form between the gall-bladder and the surrounding structures, and these tend to modify its shape when it is distended with bile, mucus or mucopus. It may assume a sausage shape, or have a curved outline, the curvature being partly outward and partly inward. When the gall-bladder is distended with fluid and contains gall-stones, its shape as seen in the skiagram may vary from time to time. When the fluid contents are expelled it contracts. Thus it may be pear-shaped at one examination and sausage-shaped at a subsequent one. The organ may become fixed by adhesions to the duodenum or colon, so that the direction of the shadow will vary and instead of pointing directly downward or downward and outward, it is displaced inward.

Very rarely when inflammatory conditions have subsided, calcareous deposits may form in the walls and throw a shadow in the radiogram. This may simulate calcareous deposit on the wall of a liver abscess which has subsided, and it is difficult to differentiate between the two.

A small hydatid cyst may cause difficulty. The clinical history will be an important factor in deciding the nature of the shadow. The hepatic flexure of the colon passes across the kidney and the pelvis in the anteroposterior view, and if the preparation of the patient has been imperfect or inadequate the kidney shadow may be obliterated by gas distention of the bowels. We have found that salts are liable to cause troublesome gas distention of the colon. The best method of preparation is to give small doses of castor-oil, licorice powder, cascara or confection of senna on two nights before the examination, with a low diet for a day, and avoidance of food on the morning of examination. In the lateral view the hepatic flexure of the colon will be seen in front of the second and third lumbar vertebrae, lying immediately over the pelvis of the kidney in a lateral pyelography.

PSOAS ABSCESS

Though not at all common, this condition in certain forms may throw a shadow which simulates a distended gall-bladder. Of a large number of cases of spinal caries examined, only one was found which could give rise to difficulty in diagnosis. The chief diagnostic point is the presence of caries of the spine at a higher level than the abscess. The shadow of the abscess may be long and pear-shaped, and present a decided curve in its outline. In the case referred to there existed unmistakable evidence of spinal caries involving two or three of the bodies of the dorsal vertebrae. The abscess presented a long banana-shaped form, narrow at its upper extremity and widening as it proceeded downwards, until at the level of the pubic arch it showed a definite rounded outline. The sac of the abscess was distended with pus and debris, and in no part was there any indication of a varying density such as would be shown by gall-stones. The diagnosis of psoas abscess was made, and confirmed by operation.

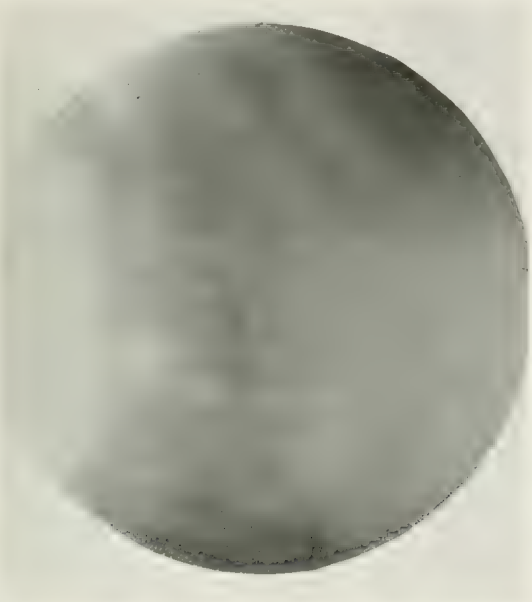


FIG. 14. Lateral pyelogram of case of small shadows in kidney and gall-bladder region.

SHADOWS IN THE KIDNEY AND GALL-BLADDER

So far as radiology is concerned, there are a number of pathological conditions which present themselves for diagnosis in a limited area in the upper abdomen. Of these, lesions of the kidney and ureter come first in order of importance and frequency of occurrence. Next to the kidney come lesions of the gall-bladder and bile ducts, and then lesions of the pancreas, particularly calculus of the pancreatic duct. The duodenum may also have to be considered, and lesions of the suprarenal glands, such as calcareous deposit or growth, are occasionally the subject of diagnosis. Lesions of the liver, especially if chronic, and the seat of degenerative calcareous changes, will at times present difficulties in differentiation. Calcification in the lymphatic glands will throw dense shadows, which may be confused with renal or biliary calculi. Calcification of

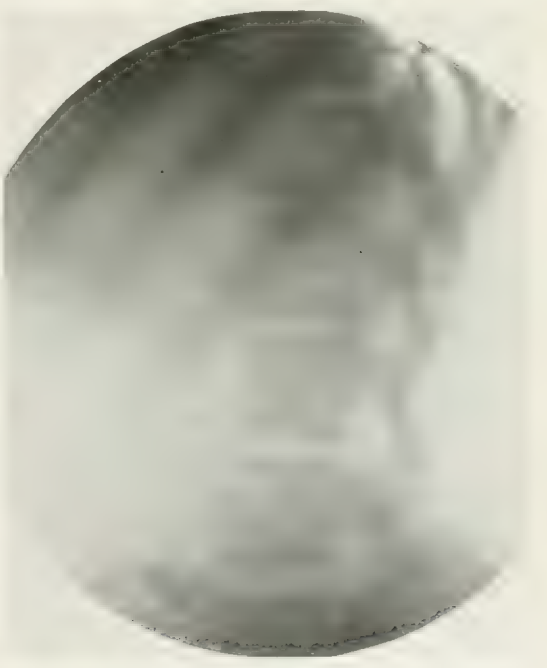


FIG. 15. Lateral view. An irregular dense shadow in front of the interspace between third and fourth lumbar vertebrae, ½ in. in front of the anterior aspect of the bodies of the lumbar vertebrae. Calcareous gland.

areas of the aortic walls may give doubtful shadows, as will also dilatation of the abdominal aorta in that region. Foreign bodies in the stomach and intestines may lead to discussion, but are easy to identify.

The chief radiographic difficulty is to distinguish between renal and gall-bladder lesions, especially calculi in these organs. A urinary stone throws a uniformly dense shadow in the position of the calices, the renal pelvis or the upper ureter. A gall-stone throws a shadow in the area of the gall-bladder or bile ducts, which is not generally uniformly opaque. There are many exceptions to these statements, and moreover, kidney and gall-bladder areas overlap. It follows that difficulties arise in recognizing the nature and position of these shadows. To these difficulties we wish to refer.

THE POSITION OF A SHADOW IN THE KIDNEY-GALL-BLADDER AREA

The stereoscopic method has many valuable applications and the measure of success to which it may be used by an expert was demonstrated by the late Dr. Macleod of Shanghai.[1]

The method is open to the grave objection that an accurate result can only be obtained where the two negatives are taken with a very short interval between the exposures. The slightest movement, respiratory or otherwise, on the part of the patient between the exposures, may lead to serious error in the subsequent calculations. And when all has been accomplished it is only possible to say that the calculus lies at a definite depth from the skin surface which during the exposure was in juxtaposition with the sensitive surface of the film or plate. To localize accurately the depth of the shadow from the surface is nevertheless of definite clinical value, and where the different organs lie in superimposed planes the knowledge of the plane proper to each organ will give an additional factor necessary for the localization in one or other organ.

The valuable table prepared by Dr. J. Metcalfe and the late Dr. Keys Wells gives the following data, which are useful in estimating depth measurements either in stereoscopy or with negatives obtained in three positions:

Thickness of abdominal wall from back to:

1. Transverse process of third lumbar vertebra = 4 to 5 cm.
2. Anterior level of third lumbar vertebra = 11 cm.
3. Anterior level of psoas muscle = 15 cm.

From these data it is possible to estimate whether a shadow representing a stone is inside or outside a kidney which is normal in position and size. The position of the gall-bladder in relation to the abdominal wall is not given in this table. If the thickness of the abdominal wall at a point 1 cm. on either side of the middle line at the level of the umbilicus is taken as 3 cm., the fundus of the gall-bladder is known to lie close to the posterior surface of the anterior abdominal wall. The gall-bladder is from 7 to 10 cm. long, and is directed backward and toward the middle line. A gall-stone may therefore be situated at any point between 3 cm. and 13 cm. from the anterior surface of the abdomen. It must be admitted, however, that the organs do not occupy exactly superimposed planes, but have a much less regular relationship; and further, an organ such as the kidney does not, on account of its mobility or abnormal mobility, or from its enlargement in disease, necessarily occupy the plane normally assigned to it, or retain its accepted relationship to other organs. It follows, therefore, that there are limitations in the stereoscopic method that do not apply to the lateral method.

A gall-stone situated at the neck of the gall-bladder, or in the cystic or common duct will have a position very different from that of a stone in the body of the gall-bladder, especially if the latter is distended and displaced forward and downward. It may be in front of the kidney shadow and cause great difficulty in diagnosis, even when all positions are employed. The stone in the common duct will lie just in front of the anterior border of the lumbar vertebrae when the patient is examined in the lateral position.

---

[1] Macleod, Neil. An unexpected solution of a pelvic radiograph problem. *Arch. Radiol. & Electroth.*, Jan., 1921, xxv, 234.

Some of the difficulties that arise are illustrated by the radiograms obtained during the examination of a case which came under the notice of the writers. Multiple shadows were shown. It was determined definitely that a large shadow in the renal region was due to a calculus filling the renal pelvis and extending into the calices. At the lower limit of the renal calculus a large oval shadow was seen. This had a central opacity surrounding which was a less opaque area, and at the extreme periphery an irregularly dense outline was seen. (Figs. 12 and 13.) Doubt arose regarding this shadow, although it certainly had the characteristic appearance of a large gall-stone. In the anteroposterior view first taken, it was overlapped in part by the calculus in the kidney, and the shadow of the kidney also overlapped it. But in a subsequent exposure it lay below the shadow of the kidney stone. An opaque catheter was introduced into the ureter. It passed the lower shadow and entered the kidney at the upper limit of the renal calculus. A lateral radiogram showed clearly that the doubtful shadow lay in front of the spine, and the diagnosis of gall-stone was made. At operation the kidney was removed by the lumbar route, and was found to contain large calculi in branching arrangement. The gall-bladder was opened by the anterior route, and one large and fifty small stones were removed. The examination in this case shows how very thorough must be the technique when doubtful conditions exist. In the radiograms taken in the anteroposterior and the posteroanterior positions, several faint shadows due to biliary calculi were seen, but the majority of the small biliary calculi were lost in the renal shadow and that of the kidney stone. The lateral position and the opaque catheter gave much help in the diagnosis. Stereoscopic radiograms would have been useful in this case, though it is doubtful if one could have made any definite statement unless accurate depth measurement had also been made.

FIG. 16. Lateral view of branching kidney calculi.

FIG. 17. Lateral view of stone in calyx showing stone shadow behind the vertebral bodies.

SIZE AND SHAPE

Both renal and biliary calculi may attain a very large size, and both may, when large, have an oval or round shape. A large round or oval shadow, if thrown by a kidney stone, will be accompanied by a large kidney, which is readily palpated in the loin, for in such cases the kidney is usually dilated with urine or pus. It may be stated, therefore, that where a large oval or round shadow appears in the loin without urinary symptoms and the kidney is not palpable, the shadow is more likely to be thrown by a gall-stone than by a kidney stone. There are, however, some remarkable exceptions to this generalization. A wedge-shaped shadow is characteristic of a stone in the renal pelvis. An irregular or branching shadow is never due to a biliary calculus, and a branching shadow is certainly renal. The difficulty seldom arises over the large calculi, but over a small oval or round shadow, which might be thrown by a renal or by a biliary calculus.

DENSITY AND UNIFORMITY OF THE SHADOWS

A renal calculus will, as a rule, throw a heavier shadow than a biliary calculus. A renal calculus shadow is usually homogeneous, and a gall-stone usually shows some detail of structure, the most characteristic of which is a marginal ring of increased density. This ring, together with a central nucleus, gives a shadow which is peculiarly characteristic of a gall-stone. But there are misleading shadows where the character of the renal stone shadow resembles that of a gall-stone. An example was a case of stone in the kidney where the nucleus and denser margin were both clearly seen, and which gave rise to serious doubt regarding its position. On the other hand, a gall-stone may give a very dense shadow which would indicate, if the density were taken as a guide, that its position was in the kidney. On the evidence of such a uniformly dense rounded shadow in the right renal region, a patient had the kidney explored for stone with negative results, before she consulted one of the writers. When examined, she complained of pain in the right upper abdomen, but had never suffered from hematuria or of jaundice. Pyelography showed that the shadow lay apart from the renal pelvis and calices, and the gall-bladder was opened and the stone removed.

Taking the majority of shadows of calculi, it may, however, be assumed that the large dense homogeneous shadow is more likely to be due to calculus in the kidney than one situated in the gall-bladder, but that the nature and appearance of the shadow cannot be taken as an absolute diagnostic guide.

Faint shadows in the gall-bladder and kidney regions have been overlooked because the type of negative does not show sufficient detail. When the negative is very dense from overexposure, overdevelopment, or both, a very powerful illuminant will reveal an evidence of a shadow which should be helpful. The detail of gall-stones may be faintly perceptible to ordinary vision in ordinary illumination, and oblique illumination may give assistance. Colored screens may be interposed between the negative and the source of illumination. Such faint shadows have generally been attributed to bowel contents or other extraneous matter. Experience shows that although a number of calculi may be present in the gall-bladder, only a small number may throw a shadow. Yet a single distinctive shadow is sufficient for diagnosis.

There is a type of kidney stone that may give rise to considerable difficulty in obtaining a shadow, and when a shadow is demonstrated it is so faint that doubt as to its character may arise. This is a thin flat stone lying with its flat surfaces facing anteroposteriorly. Such a stone is difficult to find at operation. It lies wedged in the pelvis, and is so thin that it cannot be felt on palpation outside the kidney or pelvis. It is easily missed with an exploring probe, and may even be missed by the finger. The faintness of the shadow in these cases, when the final diagnosis rests upon the *x*-ray examination, always raises the question as to whether it is a gall-stone.

It has been pointed out by Carman[1] that gall-stones may be of less density than the medium in which they lie, and under these conditions the gall-stones are indicated by an area of less opacity than the surrounding structures. They will therefore show on the negative as darker areas. And this especially occurs in gallstones lying in a bladder distended with bile, pus, or mucopus. In this relationship it may be noted that Dr. Simon refers to a case where a lesser opacity gave rise to suspicion of the presence of a stone situated in the common duct. Similarly in the opaque meal examination, a deformity of the opaque material may be caused by a gall-stone of low opacity.

---

[1] Carman, R. D. The Roentgen Diagnosis of Diseases of the Alimentary Canal. Philadelphia, 1921.

The following experiment demonstrates conclusively the accuracy of these observations. A large gall-stone composed chiefly of cholesterin was *x*-rayed in the usual way. It was then placed against a film, and a box containing water was placed between it and the *x*-ray tube. A very definite "positive" shadow was obtained. The stone was now wrapped in a thin sheet of gutta-percha tissue and placed in the water close to the distal side of the box. The negative produced a "negative" shadow. The water had absorbed relatively more of the radiations than the gall-stone. The gall-stone displaced a volume of water equal to its bulk, and the quantity of water so displaced had a relatively higher absorption equivalent than the gall-stone which displaced it. It is therefore possible that in examining negatives for the presence of gall-stones, we look for the wrong type of shadow, and may altogether miss the stone if we fail to realize that a small "negative" opacity may indicate the presence of the object for which we are searching.

In this relationship it is interesting to note that Dr. Lynham, whose attention has been called to this point by the experimental work described, recently diagnosed the presence of gall-stones on the negative shadow.

GROUPING OF SHADOWS AND THE EFFECT OF RESPIRATION

When a number of shadows are present, their arrangement will conform, to some extent, to the shape and axis of the cavity in which they lie. Calculi in the kidney and calices tend to radiate outward from the position of the pelvis which lies at the edges of the psoas at the level of the transverse process of the second lumbar vertebra. Shadows in the gall-bladder, on the other hand, radiate downward or downward and outward from the angle formed by the twelfth rib and the body of the twelfth lumbar vertebra. Where a line of calculi can be traced, therefore, the line of the renal calculi would tend to cross that of the biliary calculi.

In a male patient there had been two operations on the kidney for mobility and an abdominal exploration, and indefinite pain persisted over the right upper abdomen. The *x*-ray examination showed four small shadows lying like a string of beads

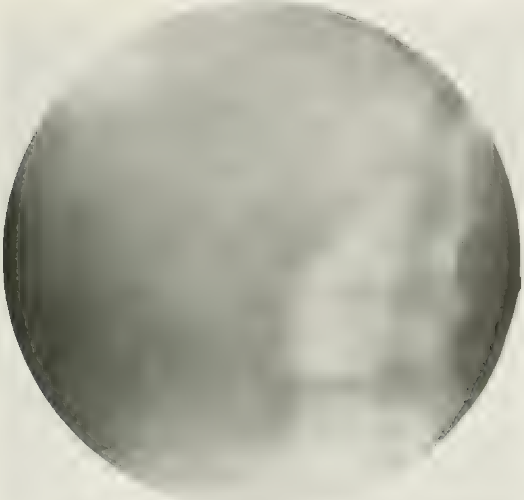


Fig. 18. Kidney stone resembling gall-stone in lateral view, excluding gall-stone. Both kidneys contained stones, on the right side one oval calculus had the *x*-ray appearance of a gall-stone.

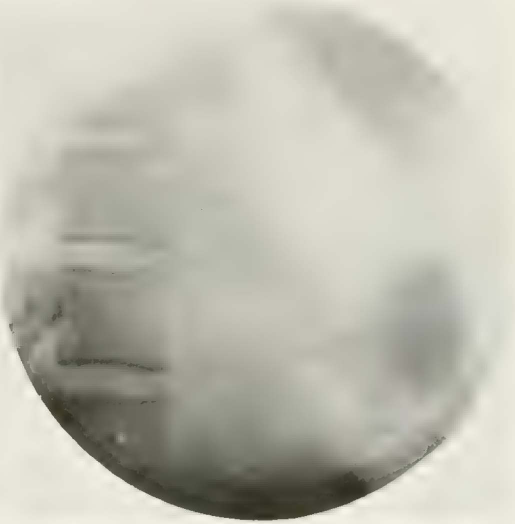


Fig. 19. Large gall-stone in lateral view.

in the kidney-gall-bladder area. Pyelography showed a normal renal pelvis, and demonstrated the calices except the upper calyx, the position and direction of which, radiating from the pelvis, was represented by the string of shadows. The axis of this line of shadows crossed that which would represent a string of calculi in the gall-bladder ducts. The shadows were also denser and more uniformly opaque than would be expected in gall-bladder stone shadows, and the diagnosis of kidney stones was made on these points, and subsequently confirmed by abdominal exploration and examination of the gall-bladder.

The grouping of a large mass of renal calculi into a main mass in the pelvis with radiating branches in the calices, and the mosaic of shadows produced by the gall-bladder filled with gall-stones, are each so characteristic of the respective organs as to leave no margin of error. In some difficult cases where only one shadow is present, the following method has proved useful:

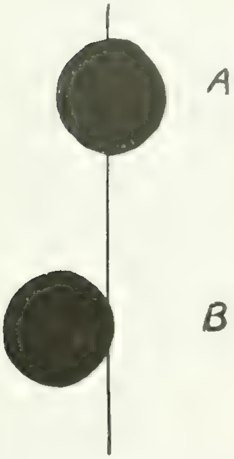


Fig. 20. Diagram showing direction of movement of kidney stones.

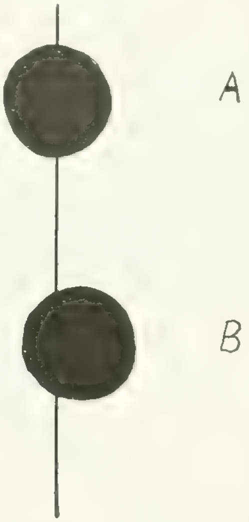


Fig. 21. Diagram showing direction of movement of gall-stones in gall-bladder.

Two exposures are made on one plate, the one in full expiration and the other in full inspiration. The direction and extent of movement are noted. The kidney stone moves downward and outward, and the extent of the movement is less than that of the gall-bladder under the same conditions, i.e., where the plate is nearest to the spine, as in the usual kidney position. The movement of the shadow of the gall-stone, which is lying free in the cavity and at the lowest point of the gall-bladder will be almost directly downward with a slight displacement inward, and will show a greater amount of movement.

A gall-stone in the common duct or the cystic duct is fixed, its displacement will be less marked on deep inspiration, and its line of movement will approximate that of the kidney stone.

PYELOGRAPHY

By pyelography the shadow which may lie within the kidney area, and actually within the limits of the kidney shadow, may be proved to lie outside the kidney. The shadow of a kidney stone will lie engulfed in or at least be continuous with the shadow of the renal pelvis or one of the calices. A shadow which lies apart from the pelvis or calices, as shown by pyelography, is not thrown by a renal calculus. The so-called cortical stone, a stone embedded in the renal cortex, and not connected with the calyx, has no existence outside the older textbooks. Where therefore, the suspicious shadow is shown to lie apart from the pelvis and calices as shown by pyelography, the diagnosis will be a gall-stone and not a kidney stone.

But where the shadow is continuous with or superimposed upon a calyx or the pelvis, the stone may be, and usually is, a kidney stone. Fallacies do exist in regard to this point, but they are cleared up by the lateral position.

Where pyelography shows the presence of a stone in the kidney, the localization of the stone to the calyx in which it lies, or to the pelvis, is accurate and of much assistance to the surgeon when the stone is small and its removal is proposed. But here again there is a source of fallacy, for in the experience of the writers a small stone demonstrated by pyelography to lie in a calyx at the upper pole, may be found at operation to lie in a calyx at the lower pole, or in the pelvis. Too much reliance, therefore, cannot be placed upon this form of localization as an aid to operation.

With an opaque catheter in the ureter and the renal pelvis filled with opaque material, the shadows thrown by calcified glands are conclusively shown to lie extrarenal, and where a single shadow is present, there is no difficulty in demonstrating that it is outside the ureter.

LATERAL RADIOGRAPHY AND PYELOGRAPHY

In lateral radiography with the kidney in its normal position, and where no great enlargement of the organ is present, a kidney stone will throw a shadow on that of the body of the second lumbar vertebra. A stone occupying the extreme limit of a calyx may throw a shadow which appears behind the body of the vertebra, but this is a rare finding, and will not give rise to confusion with any other shadow. The two conditions which may cause confusion with the shadow of a kidney stone, are gall-stones and calcified abdominal glands. The gall-stone shadow lies well in front of the shadow of the vertebral bodies, usually at the level of the upper three lumbar vertebrae, but sometimes as low as the fourth lumbar vertebra.

The shadows of calcified abdominal glands may lie in the kidney region, but usually they are lower down, and in the lateral view in front of the bodies of the third or fourth lumbar vertebrae. An example of such a condition was a lady who had, a few years previously, been operated upon for stone in the right kidney. The kidney and stone had been removed. Recently she experienced symptoms similar to those previously complained of, and a doubt existed as to their cause. A negative in the anteroposterior position showed a large shadow in the renal region, situated near the position of the lower pole of the left kidney, and lying in front of the ureter. A lateral roentgenogram demonstrated the shadow some distance in front of the ureter, and therefore not causing pressure symptoms.

In cases where any doubt exists as to whether a shadow or group of shadows is thrown by renal calculi or by calcified glands, anteroposterior and lateral pyelography should be carried out. The exact relation of the renal pelvis and of the ureter to the doubtful shadows is demonstrated clearly.

Objections have been raised to the use of the lateral method. It is difficult to get satisfactory negatives in stout patients. This is a matter of technique and applies to the anteroposterior as well as to the lateral position. An improving technique will show an increasing number of successful lateral radiograms in stout patients. It is stated that it is not possible to demonstrate gall-stones in the lateral position. This is not the case. It is not possible to show all the gall-stones in either position, but a gall-stone, which in the anteroposterior or posteroanterior position shows a definite shadow, should be almost as readily shown when a good lateral negative is produced. Most renal stones will show in the lateral position through the shadow of the spine. Should a shadow which is very distinct in either or both of the first two positions, not appear in front of the spine in the lateral, we may be reasonably certain it is not a gall-stone. It may have been lost in the shadow of the vertebral bodies, but if it occupies that position, it is not a gall-stone. An exception which might cause some difficulty would be a small gall-stone in the common duct close to the duodenum. The shadow might be near enough to the spine to suggest the possibility of a kidney stone. Pyelography is of great value in such a case. The clinical symptoms may decide the diagnosis apart from the *x*-ray examination, but exploration may be necessary to settle the diagnosis. A practical point of some importance in the technique of gall-bladder and kidney radiography is to realize the type of negative at which it is desirable to aim. The earlier kidney radiography led to the production of a number of first-class negatives of that region, and no better technical work has been produced in recent years. The detail of bone is remarkably good in these negatives, the aim of most workers being to produce a high-class negative with strong contrasts in the bones. This type of negative is quite good for the demonstration of stones of considerable density and of fairly large size. The smaller and less dense stones are likely to be missed, while gall-stones are rarely shown in this type of negative. It is considered better in later work to aim at a negative which will give good detail in the softer parts, the bone detail being a secondary consideration. In development it is well not to carry the process too far, as a fairly thin negative is required.

ACUTE MEDIASTINAL ABSCESS: REPORT OF FOUR CASES IN CHILDREN*

BY ORRIN S. COOK, M.D.

From the Roentgen Ray Departments of the Children's Hospital and the University of California Hospital

SAN FRANCISCO, CALIFORNIA

A HASTY and more or less superficial search of the literature has revealed very few references to the subject of mediastinal abscess in the general medical literature and practically nothing on the roentgenological aspects of the condition. Where the subject is mentioned it is usually the chronic, so-called "cold abscesses," associated with tuberculosis of the spine, which are referred to.

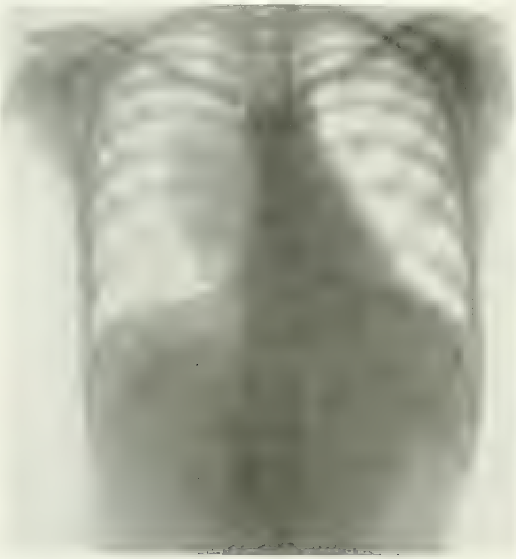


Fig. 1. Case I.

That the condition is not a common one is shown by the fact that there were only 2 cases in more than 600 children whose chests were examined in the *x*-ray department of Children's Hospital in the last two years, and only 2 have been found in the University of California Hospital.

In view of these facts I have thought it worth while to put these cases on record.

Case I. Female, aged eight years. Entered the University of California Hospital June 3, 1919, with a diagnosis of bronchopneumonia. This condition gradually cleared up and the temperature dropped to normal. After a few days the temperature came up again with a septic swing. The child was sent to the roentgen-ray department on June 16th for examination for a suspected empyema. The roentgenogram (Fig. 1) showed a shadow of increased density on the right, continuous with the posterior mediastinum and extending outward into the right chest. The outer border was sharply outlined but it faded out and became indistinct above. These findings remained constant for about three weeks but the child did not improve. Accordingly, on July 10th the tenth rib on the right was resected close to the spine, and the abscess found and drained. The temperature immediately dropped to normal and remained there for several days. However, on July 18th the temperature rose again, due to a recurrence of the bronchopneumonia, and the child died July 23rd. No post-mortem was obtained.

Case II. Female, aged eleven years. Was admitted to Children's Hospital Jan. 10, 1922, with an entrance diagnosis of empyema. There was a history of lobar pneumonia in the right lower and left upper lobes beginning two weeks previous to entry. Five days previous to entry the temperature dropped to normal and then came up again with a septic swing. Roentgen examination on Jan. 11th (Fig. 2) showed an empyema on the right with a second shadow projecting beyond the right border of the sternum and with a well-defined right border which was visible through the empyema shadow and was somewhat nodular in outline. This was thought to be a mass of substernal glands. A rib was resected and the empyema drained on Jan. 12th., after which the temperature dropped almost to normal for two days and then came up again. The child did very badly for several days in spite of good drainage from the wound. A second *x*-ray examination (Fig. 3) showed good drainage of the empyema cavity, but the substernal shadow was still present. On the morning of Feb. 7th, while the nurse was doing the dressing, the child coughed and there was a sudden profuse discharge of pus from the wound. A roentgenogram was made immediately and the substernal shadow was found to have diminished markedly in size. There was profuse drainage for several days, after which the temperature returned to normal and drainage gradually ceased. Convalescence was rapid, and a roentgenogram taken March 17th (Fig. 4) showed the chest clear except for some thickening of the pleura.

---

* Paper submitted leading to membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1923.

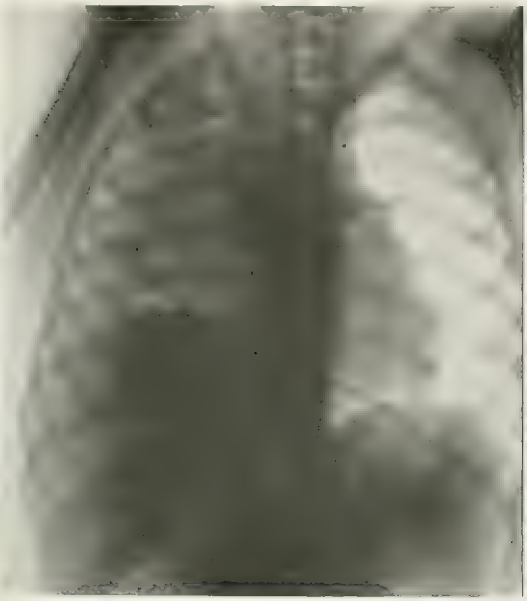


Fig. 2. Case II before drainage of pleural sac.

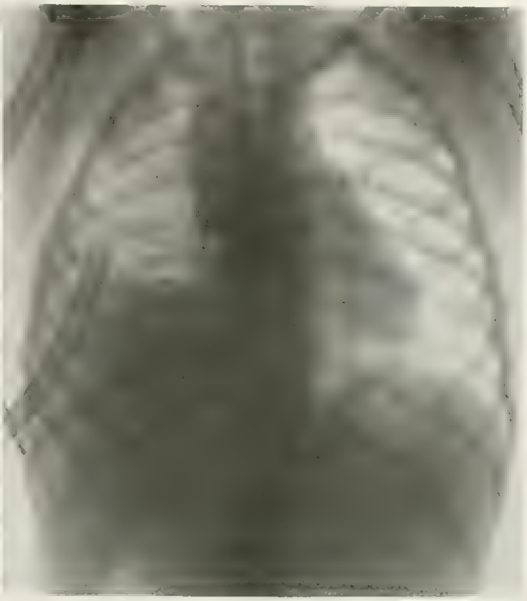


Fig. 3. Case II after drainage, showing separate substernal accumulation.

Case III. Male, aged eight months. Was admitted to Children's Hospital Feb. 19, 1922, with a history of an acute respiratory tract infection of two weeks' duration which had been treated by a Chinese doctor and which had suddenly become worse. The entrance diagnosis was bronchopneumonia. A roentgenogram taken a few days after entry showed a bronchopneumonia and a sharply-outlined shadow apparently continuous with the posterior mediastinum and extending into the right chest in the region of the right upper lobe.

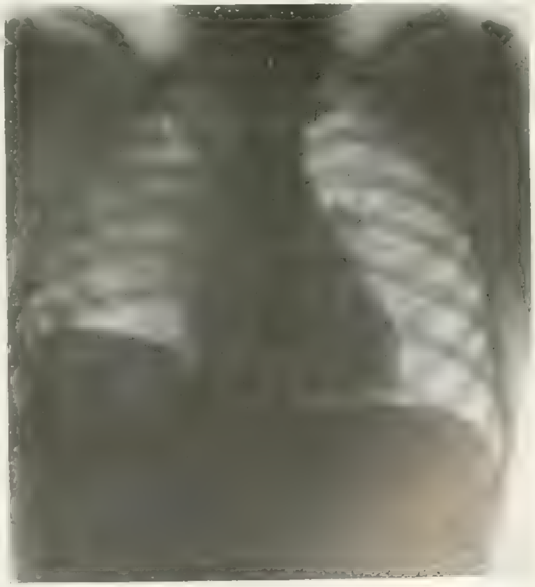


Fig. 4. Case II following recovery.

This plate has unfortunately been lost or misplaced. The shadow gradually increased in size until it reached the dimensions shown in Figure 5. On March 9th a thoracentesis was done posteriorly at the level of the fourth dorsal vertebra as close to the spine as possible, and pus was obtained. This was repeated several times in the next few days, and pus obtained each time. On March 26th a large trochar was passed in and a great amount of purulent fluid withdrawn. The temperature rapidly dropped to normal after this and convalescence was rapid and complete.

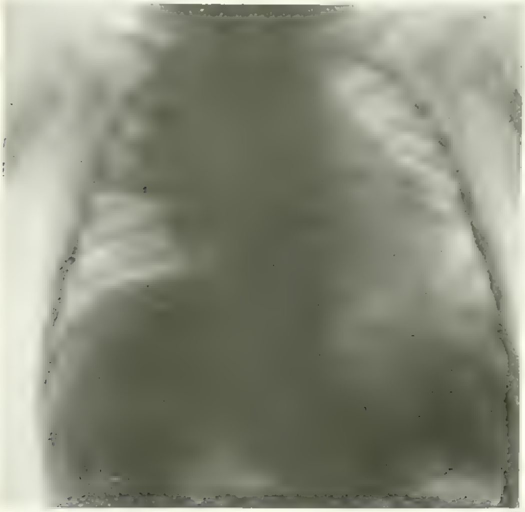


Fig. 5. Case III.

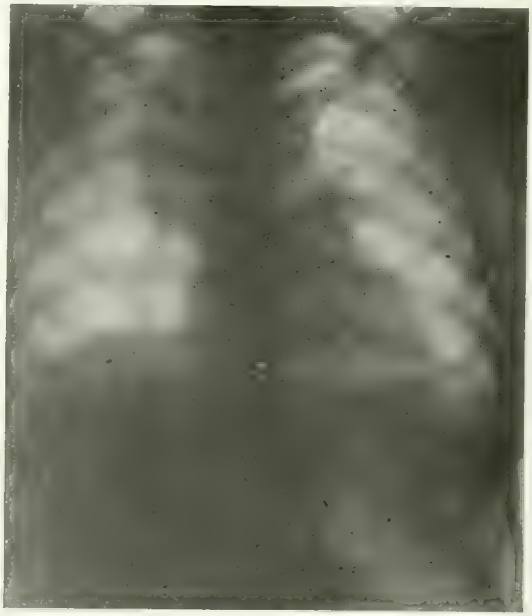


Fig. 6. Case IV.

Case IV. Female, aged sixteen. Entered Hahnemann Hospital March 2, 1922. There was a history of a severe sore throat complicated by an edema of the larynx requiring an emergency tracheotomy ten days previous to admission. The tracheotomy tube had slipped out the next day, allowing some of the purulent tracheal secretion to escape into the soft tissues. The temperature and blood count soon began to rise and the patient was brought to the hospital with a diagnosis of suspected mediastinal abscess. A roentgenogram taken March 3rd (Fig. 6) shows a well-defined shadow in the right chest apparently continuous with the mediastinum which was interpreted as a mediastinal abscess. No attempt was made to drain the abscess and treatment was purely symptomatic. The temperature stayed up for several days and then gradually fell to normal. The patient was discharged as well March 30th, but there was no change in the roentgen appearance of the shadow.

EXAMINATION OF THE POSTERIOR MEDIASTINAL GLANDS IN THE EARLY RECOGNITION OF PULMONARY TUBERCULOSIS*

BY LLOYD B. CROW, M.D.

Roentgenologist, Southern Pacific Railroad General Hospital

SAN FRANCISCO, CALIFORNIA

THE recognition of early pulmonary tuberculosis, notwithstanding great advance in our knowledge of the subject, is still frequently most difficult, especially in those cases in which the disease does not manifest itself by any physical or conclusive signs in the chest. It has, therefore, been my endeavor in the past four years to find some roentgenological sign by which the early and obscure manifestations of the disease may be recognized before the lung itself shows gross morphological change.

If it be possible to make a diagnosis of pulmonary tuberculosis, based on recognized evidence of changes other than lesions of the lungs themselves, it is obvious that the chances for the patient's recovery will be greatly enhanced. It has, at times, been my privilege to give the physician such evidence, permitting him to correlate the early clinical manifestations of pulmonary tuberculosis with demonstratable lesions outside the lungs. This I believe can be accomplished by examination of the glands in the posterior mediastinum in all chest examinations when pulmonary tuberculosis is suspected.

The lymphatic vessels of the lungs consist of two sets, the superficial and the deep. The former are placed beneath the pleura and cover the outer surface of the lung. The latter accompany the blood-vessels and run along the bronchi, where they terminate at the root of the lung or hilus region. These glands are intimately connected with those of the posterior mediastinum. The lymphatic vessels of the esophagus form a plexus around that tube, traverse the glands in the posterior mediastinum, and after communicating with the pulmonary glands and vessels at the root of the lung, terminate in the thoracic duct. The posterior mediastinal glands are situated in the areolar tissue of the posterior mediastinum, forming a continuous chain by the side of the aorta and the esophagus, communicating on each side with the intercostals below, and with the lumbar glands and the deep cervical above.

Therefore, this brief study of the lymphatics of the posterior mediastinum and their connections permits one to note the possibility of infection from the nasopharnyx and the buccal cavity taking place directly to the hilices of the lungs through these channels. These premises have led me to make a complete roentgenological investigation of the glands of the posterior mediastinum in both disease and health. Special attention has been paid to changes in the posterior mediastinal glands in pulmonary tuberculosis. This study has aided me in arriving at some very definite roentgenological conclusions.

I shall not attempt to describe any of the experimental work that has been done in the way of determining the portals of infection in pulmonary tuberculosis, as space in this modest monograph does not permit. However, I will say that some authors, notably some of the French school, believe that it is impossible to infect the lungs of animals directly by the respiratory channels, and that tuberculous infection takes place by other channels than those of the respiratory passages. These premises are possible when a thorough consideration of the anatomy of the lymphatics connecting the buccal cavity with the hilus of the lungs is made.

Technique. The patient stands at an angle of 45 degrees, with the left scapula resting against the fluoroscope and the right shoulder touching the screen. This position must be varied in order that the maximum amount of space between the heart and the vertebral column be obtained in the visualization of the postcardiac space. This is done by rotating the patient backward and forward until the desired angle is obtained. The postcardiac space is first visualized with the open diaphragm and a quick survey of the entire field is made. If considerable infiltration has taken place, the whole field is darkened and very little fluorescence takes place in this portion of the screen. If the infiltration is fairly heavy, a distinct chain of glands is seen extending from the upper portion of the space to the hilus region, and in some cases to the inferior portion of the space. When the infiltration is slight, thin narrow lines are seen extending downward throughout the space like strands of rope. In some instances infiltration is limited to the glands entering the hilices of the lungs, the glands in the upper and lower portions not being visualized. It is also true that many normal cases show infiltration of the glands in the postcardiac space, but when these are present there is usually a history of some recent or previous lung involvement. It has been my experience to note that many cases of recovered tuberculosis show involvement of the posterior mediastinal glands; but instead of the general involvement obstructing the greater portion of the space, as seen in active cases, these cases show distinct rounded shadows forming a chain giving the appearance of scattered shot of different calibrations.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 192[illegible].

Advanced cases of pulmonary tuberculosis usually, but not always, show involvement of the postcardiac glands. In the fulminating type I have seen the postcardiac space present almost a clear appearance. In these cases the glands are undoubtedly offering very little resistance to the advance of the disease. In the chronic fibroid type I have seen the postcardiac space filled in its entirety, due undoubtedly to a great effort of the organism in its endeavor to block the advancing infection.

My first attention to the value of the examination of the postcardiac space in the early diagnosis of pulmonary tuberculosis was made while examining a young nurse in training, who had been brought to the radiological department of the San Francisco County Hospital for special study of the lung fields. It appeared that she had complained for three months previous, of a slight cough attended by a rise in the evening temperature. As this occurred during the epidemic of influenza which visited San Francisco about that time, it was first regarded as a post-influenzal complication. Repeated physical examinations had been made, but nothing had been determined to account for her subjective symptoms. At first there was no loss of weight and the patient looked in the pink of condition.

In fluoroscoping the case I did not notice any pathological change in the lung fields themselves, but in turning the patient from the anteroposterior position to the posteroanterior position, I visualized, much to my astonishment, a large clump of glands in the posterior mediastinum, in its upper portion, very heavily infiltrated. Those in the inferior portion of the space were less infiltrated than those above. This heavy thickening was so marked that I was at first tempted to consider a possibility of Hodgkin's disease. However, after careful study of the case I made a report stating that I considered that there was a tuberculous infection of the glands in the posterior mediastinum which had, as yet, not broken into the lung itself.

Subsequent to this examination the clinical picture changed in some respects. The patient's temperature constantly remained above normal and medication apparently had no favorable effect whatever. I advised that several series of radiations be given over the posterior mediastinal glands. This was done, and after several treatments with heavy penetrating rays, the patient's temperature returned to normal. The treatments were unfortunately discontinued as the patient was possessed with an abnormal fear of an *x*-ray burn and absolutely refused to submit to any further radiation.

I lost track of the case for several months, as the patient was sent to a sanitarium. About six months later I saw some roentgenograms, of the case made by another roentgenologist. In these studies definite lung changes were shown. A positive diagnosis of pulmonary tuberculosis was made about that time and she is now in a tuberculosis sanitarium in Colorado Springs.

In reviewing the case from the description given above and in the light of subsequent experience, it is clear to me that a provisional diagnosis of pulmonary tuberculosis would have been warranted on account of the mediastinal changes, having a definite connection with the history and physical findings of the case.

SUMMARY

As a negative sign, the non-involvement of the glands in the posterior mediastinum possesses great value in eliminating pulmonary tuberculosis where this disease is suspected.

I have examined the glands situated in the posterior mediastinum in about 4,000 cases, and have never failed to find them involved where a frank pulmonary tuberculosis was manifest.

In many cases of early pulmonary tuberculosis where practically no signs were present in roentgenograms made of the chest (and where the fluoroscope showed involvement of the posterior mediastinal glands and where there was a suspicious anamnesis), patients have been greatly benefited by being placed on treatment for suspected pulmonary tuberculosis.

OSTEOCHONDRITIS DEFORMANS JUVENILIS*

BY B. R. KIRKLIN, M.D.

MUNCIE, INDIANA

IN June, 1909, Dr. Arthur T. Legg, at the meeting of the American Orthopedic Association, reported 5 cases of "An Obscure Affection of the Hip-Joint." This paper was published in the *Boston Medical and Surgical Journal* in February, 1910, and apparently is the first contribution on this subject. In July, 1910, Dr. Jaques Calvé selected from some 500 cases of "Coxalgie" 10 cases presenting a form of "Pseudo-coxalgie." It was his opinion that this small group of cases presented differential points sufficiently characteristic to warrant a special classification and discussion. His cases were apparently identical with Legg's cases. Three years later, in 1913, Dr. George Perthes contributed the first intensive publication on this subject under the heading, "Osteochondritis Deformans Juvenalis," in which he made the first contribution to the literature of a histologic examination in a case of osteochondritis deformans juvenalis. In spite of these undisputed facts this affection is more generally known as "Perthes' disease," and from this time on appeared in the German literature under the title of "Perthes' disease." Prior to 1914, Legg's original and subsequent contributions were overlooked or ignored in the various German monographs on the subject, although, as pointed out by Sundt, references to Legg's original article appeared in three German periodicals in 1910 and 1911.

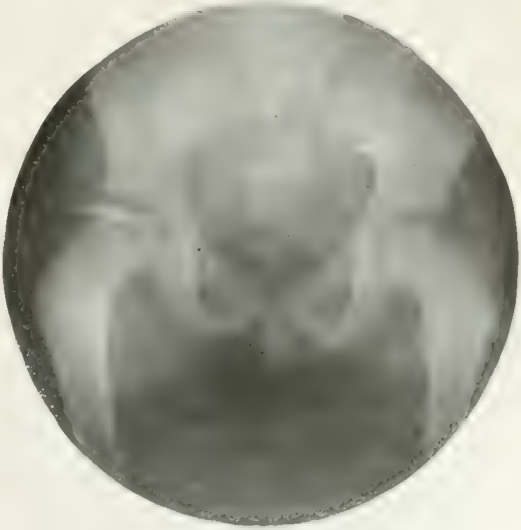


Fig. 1. Case I. Typical case.

The literature on this subject since 1915 has become voluminous and more than 350 cases have been reported. The names of Legg, Calvé and Perthes, however, must remain conspicuously associated with the original recognition of this condition.

---

* Read at the Fourth Annual Meeting of the Central Section of The American Roentgen Ray Society, Louisville, Ky., Feb. 24, 1923.

From a number of clinics a retrospective analysis of a large series of cases, formerly diagnosed and treated as tuberculous disease of the hip-joint, demonstrated the fact that the roentgenograms of many of these cases showed the appearances characteristic of this condition, and I believe that most of the active cases which I personally have seen have been referred with a clinical diagnosis of tuberculous hip-joint disease.

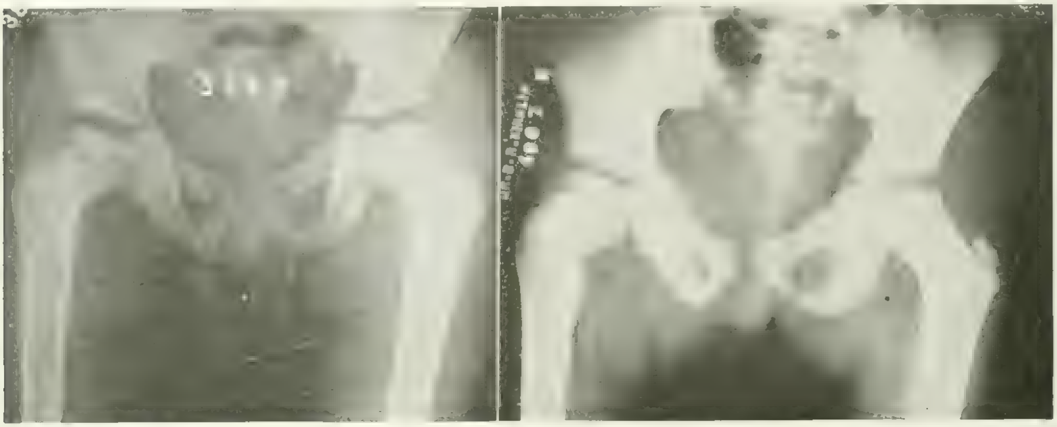


FIG. 2a and b. Case II. Roentgenograms made one year apart, showing gradual progress of disease.

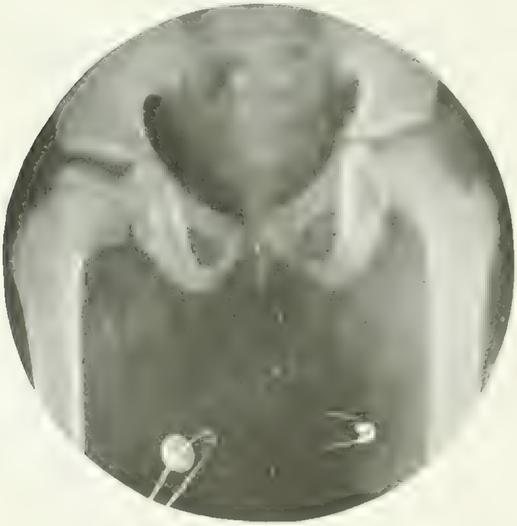


FIG. 2c. Case II. Roentgenogram made one year after Figure 2b.

This condition is met with principally in children in the first decade of life, is more common in boys, and its inception is often associated in the minds of the parents with some recent injury in the region of the hip. In its early stages it closely resembles tuberculosis of the hip, due to its gradual onset without early marked symptoms, but in its later stages shows a vast difference. A slight limp, occurring early and persisting late, becoming more and more intermittent, and accompanied by slight or no pain, is the obvious symptom. The limp, according to McChesney, may last from two to four years and then lessen, in spite of greater destruction of the epiphysis. Limitation of abduction persists much as the limp does. Slight shortening and atrophy are only occasional symptoms. Pain is almost a negligible factor.

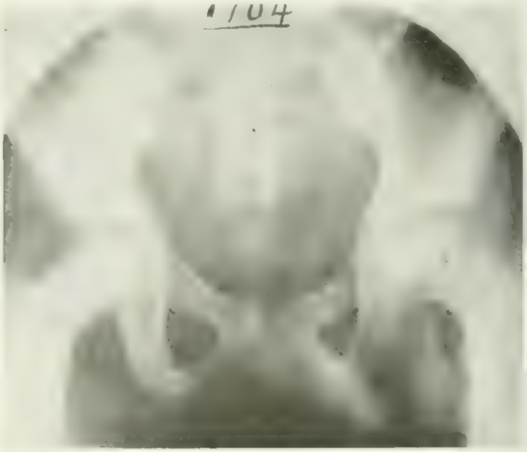


FIG. 3a. Case III. Shows more marked destruction of epiphysis.

The affection usually terminates in recovery with a remodeled joint but with excellent use. The articular surface of the femoral head is extended toward the trochanter and is somewhat flat, but becomes smooth, and pain, if present, disappears and only the slight restriction of motion and the changes shown by the roentgenogram remain to identify the process. Ankylosis and fixed flexion of abduction, which are so common after tuberculous hip-joint disease, do not occur.

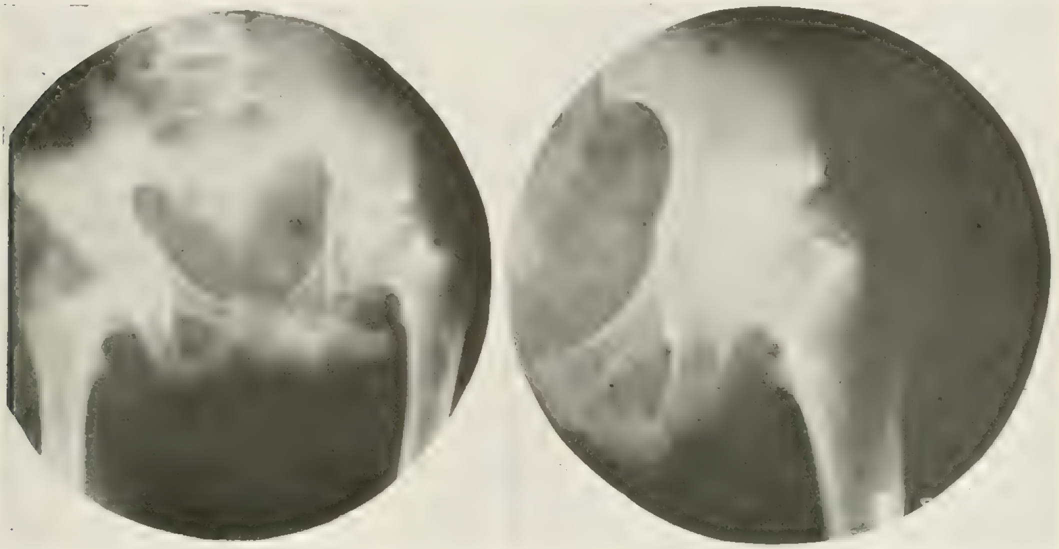


Fig. 3b and c. Case III. Note that a and b were made one year apart, while c was made two years after b.

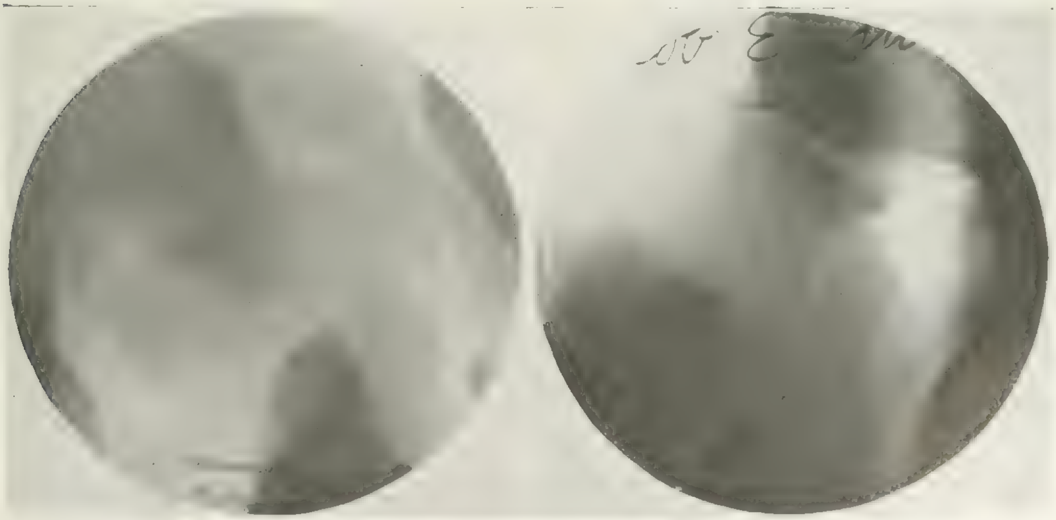


Fig. 4. Case IV. Bilateral healed osteochondritis deformans juvenilis. Served in world war.

The roentgenogram, when once seen, is very typical, so much so that most writers on the subject assert that a roentgen-ray examination alone is sufficient for the diagnosis.

The flattening or crushing of the epiphysis and broadening of the neck of the femur are the salient features. The flattening of the epiphysis is progressive, being slight at first, and increasing till the epiphysis loses its rounded outline and is reduced to a flattened plate or disc, often divided into several segments. Later these appear to fuse, and the whole is finally united to the diaphysis. There is no hazing or clouding of the joint.

The upper part of the femoral neck is seen to broaden, and becomes, as it were, rounded off. Coincident with this broadening there is a gradual shortening of the neck as a whole and an increased density (eburnation). At first sight the angle of inclination between the neck and shaft of the femur would appear to be lessened, with the development of consequent coxa vara deformity. This was originally emphasized by Calvé, and in other earlier contributions in the literature was regarded as indicating true coxa vara. But it is now generally conceded that there is no actual bending of the neck, but that the depression is apparent and not real.

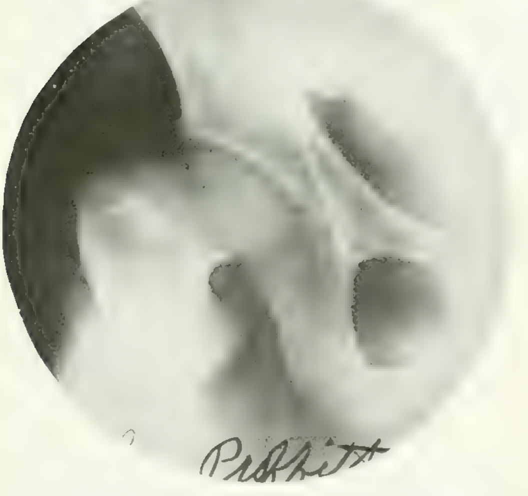


Fig. 5. Case V. Healed osteochondritis deformans juvenilis. Served in world war. Note the almost perfect articulating surfaces.

Most of the writers on this subject tend to regard the acetabular changes as relatively inconspicuous, unimportant or actually non-existent. Perthes states that the acetabulum shows no deformation except in very advanced cases. Sundt, however, writes that in the later stages the acetabulum is normal. Swartz describes late changes which he classifies as hypertrophic, and secondary to changes in the head. Platt declares that osseous changes in the acetabulum can be seen at every stage of the disease and that they should be considered partly as the adaptation of the cavity to the altered line of pressure through the deformed head, and partly as of the same nature as the transformation undergone by the epiphyseal nucleus, and thus truly specific.

The roentgenological appearances of the various other hip-joint affections are so typical that I do not think it necessary to take the time to go into the differential diagnosis of this condition.

I am indebted to Dr. C. A. Sellars, who referred Case III to us and who furnished Figure 3c.

BIBLIOGRAPHY

Baetjer. Differential diagnosis by *x*-ray between rickets, syphilis, scurvy and condition known as Perthes' disease. *Med. Clin. N. America*, 1919, ii, 1703.

Brandes and Mau. Osteochondritis deformans juvenalis and tuberculin reaction. *Méd. Klin.*, 1921, xvii, 715.

Calvé. Difficultés du diagnostic de la coxalgie au début. *Presse méd.*, February 17, 1909. Sur une forme particulière de pseudocoxalgie. *Rev. de chir.*, July 10, 1910.

Delitala. A typical disease of the femur. *Am. J. Orthop. Surg.*, April, 1915.

Fenner. Juvenile deforming osteochondritis with report of cases. *N. Orl. M. & S. J.*, 1922, lxxiv, 659.

Freiberg. The evolution of osteochondritis deformans coxae juvenilis. *J. Am. M. Assn.*, 1916, lxvii, 658.

Legg. An obscure affection of the hip-joint. *Boston M. & S. J.*, February 17, 1910; *Tr. Am. Orthop. Assn.*, June, 1909.

Legg. Osteochondral trophopathy of the hip-joint. *Surg., Gynec. & Obst.*, 1916, xxii, 307.

McChesney. Juvenile deforming osteochondritis of the hip. *J. Am. M. Assn.*, 1915, lxv, 1637.

Perthes. Osteochondritis deformans juvenalis. *Arch. f. klin. Chir.*, 1913, p. 779. Arthritis deformans juvenalis. *Deutsche Ztschr. f. Chir.*, 1910, cvii, 111.

Platt. Osteochondritis deformans juvenalis coxæ (quiet hip disease): a clinical and radiographic study. *Brit. J. Surg.*, 1922, ix, 366.

Schwarz. *Peitr. z. klin. Chir.*, 1913.

Sundt. Calvé-Legg-Perthes diseases of the hip. *Zentralbl. f. Chir.*, 1920, xlvii, 538.

Taylor and Frieder. Quiet hip disease. *Surg., Gynec. & Obst.*, 1916, xxii, 158.

Waldenstrom. Tuberculous foci of the upper part of the neck of the femur. *Ztschr. f. orthop. Chir.*, 1909, xxiv, 3. Tuberculosis des collum femoris in Kindesalter. Stockholm, 1910.

DISCUSSION

Dr. Nichols. It seems to me that this is a very important subject from the roentgenologist's standpoint, for with early diagnosis the treatment of this disease is very satisfactory. If these children are properly treated they recover, and if not, they go on to the deformities which we see in adults, so that it is important that we as roentgenologists recognize this disease early in order that these patients may receive proper treatment.

Dr. Potter. Dr. Kirklin's paper is very interesting, especially from one standpoint: What finally becomes of the head of the femur? Dr. Kirklin showed slides on one case which covered a period of four years, and there was very little change in the appearance of the head. I have seen one or two cases where, in a similar time, a great deal of absorption of the head took place. In some of the adult cases the maturely-formed head of the bone is so short and flat that a great deal of it must have been absorbed before maturity. I believe if this subject were followed up systematically it would be found that many cases show a complete absorption of the head before the other epiphyses had united and, on the other hand, I believe a certain percentage of the head would be left and unite in the regular way to the shaft.

Dr. Kirklin (closing discussion). In answer to Dr. Potter, I think these cases, especially cases II and III, are splendid ones for careful follow-up study in order to determine what happens to the epiphysis. You will remember that in each of these 2 cases, we had a yearly roentgenogram and I have already requested these cases either to return to my office once a year, or to have roentgenograms made elsewhere and sent to me that often. In this way we will be able to follow these 2 cases, providing nothing happens, for as many years as we like. And I shall be very glad to report them at some future date.

It has seemed to me that one of the earliest roentgenological findings that we see is probably the thickening of the neck of the femur.

TYPICAL DISEASE OF THE SECOND METATARSOPHALANGEAL JOINT

BY PROF. DR. ALBAN KOHLER

WIESBADEN, GERMANY

The second metatarsophalangeal joint is subject to a peculiar disease, to which I called attention in 1915 in the second edition of my book, "Grenzendes Normalen und Anfänge des Pathologischen," in the following words: "One sometimes finds in the roentgenogram at the site complained of, a joint-space of double breadth, where the second or third metatarsals, or both, articulate with the toes. There is a definite proximal displacement of the end of the metatarsal involved. There is as yet no description of this finding in the literature. The author has seen altogether 4 or 5 cases. It is obvious that the finding is pathologic, but the author is not aware of the cause or the nature of the disease."

I described my cases more minutely in 1920 at the eleventh congress of the German Roentgen Ray Society.[1] Meanwhile a number of further contributions have appeared, so that up to the present a total of about 75 cases have been recognized.

The disease involves the articular surface of the base of the proximal phalanx of the second toe (seldom the third or both together); the metatarsophalangeal joint, the articular surface of the head of the metatarsal, the head itself, and the whole distal half of the metatarsal. These structures are altered in the following manner:

1. The shadow of the articular surface of the proximal phalanx in plantar-dorsal exposures loses its perfectly circular form, and becomes irregular, often approaching an S-shape.
2. The joint-space in almost all cases is broader than normal. This is all the more remarkable because in all arthritides, aside from those with effusion, there is never a broadening, but in the presence of changes as great as in this condition, an actual narrowing of the joint-space, as if the articular cartilage had been ground away or crumpled up.
3. The joint-space is not only broadened, but the broadening is strikingly irregular, so that the fibular half of the space is often double that of the tibial half.
4. The articular surface of the head of the metatarsus loses its normal roundness; in early cases it is only more or less flat-

---

[1] See the Transactions of this Congress. An abridged account appeared in *Münchner med. Wchnschr.*, 1920, No. 45.

tened, but in old cases it shows quite irregular knobs and defects.

5. In advanced cases of long standing, on the fibular aspect of the joint, and even deep in the soft parts, are from one to several shadows indicating a density equivalent to bone; these shadows vary from the size of the head of a pin to the size of a lentil, and resemble the calcified plaques in the capsules of the large joints, but are always circular.

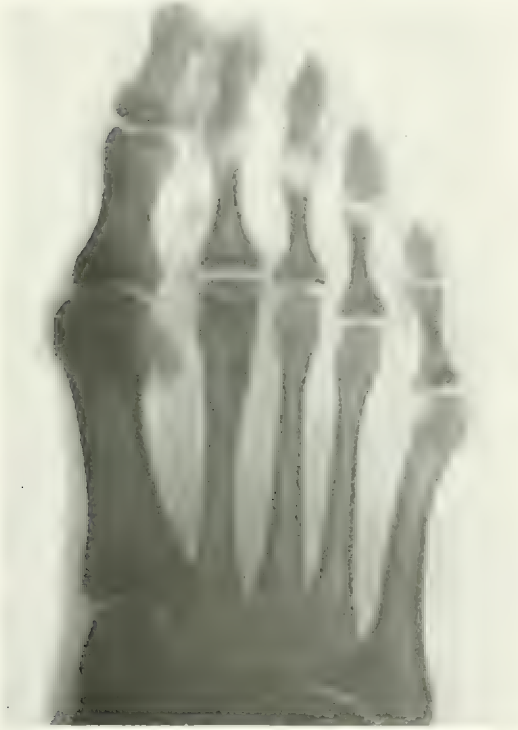


FIG. 1. A case in the early stage of the disease.

6. The head of the metatarsal is undoubtedly shortened, not *in toto*, but in its distal third, as if the cap had been driven in. This naturally makes the whole metatarsal somewhat shorter. So far, the process could be compared, though the resemblance is a remote one, to a severe monarthritis; but there is still to be considered one important feature:

7. In all frank cases the whole distal half of the metatarsal is more or less altered, and is definitely increased in circumference, so that there is no longer a constriction at the site of the neck. Thus the distal half is often like the proximal in point of size and shape. The thickening is not confined to the medulla, but also involves the cortex, which however, thins out normally toward the proximal end of the bone. What is particularly striking, in contradistinction to the changes of osteomyelitis and spina ventosa, which produce roentgenograms remotely resembling this condition, is the increase in the size of the bone distally. Also the spongiosa, as far as the tip of the bone, appears regular and of well-ordered design.

The number of cases reported up to the present—that is, in the last two and a half years, indicates that the disease is not especially rare; in any case, it is encountered more frequently than the disease that is peculiar to the navicular bone. In 9 cases out of 10, the second metatarsal is involved; one time in 10, the third alone or together with the second. In at least 2 cases, both feet were involved. The age of the patients ranged from ten to forty-eight years, but it is to be noted that in persons beyond the fifteenth to eighteenth year, the disease was very probably not of recent development, but originated in the growth-period and was accompanied by associated changes in the sense of arthritis deformans. Two thirds of the patients were from ten to eighteen years old. The disease is four times as common in the female sex as in the male. In two thirds of the cases the right foot was involved.

The patient's complaint is of pain in the region of the joint in question, especially on weight-bearing and eversion of the foot. The disturbances of locomotion are usually variable and moderate; but oftentimes the patient spares the limb, or is even lame. At all events, indulgence in sports, etc., is limited or even impossible.

Objective Manifestations. Usually a slight swelling of the soft parts on the dorsum, especially in the vicinity of the lesion, with tenderness on pressure on the dorsum or on the sole or both. Pain on motion is uncommon.

At least two authors found in their cases a bending of the epiphysis toward the dorsum of the foot. This finding is not confirmed by other authors, even by those who have sought especially for it. However, it is advisable in every case to make a roentgenogram of the profile of the foot, in spite of the disturbing shadows of the metatarsals, especially the thick first one. Further, both feet should always be examined.

Differential Diagnosis. As in case of the disease peculiar to the navicular bone so here: when one has once seen the roentgenogram, it is not easily forgotten, at least in the cases occurring in the *growth-period* (see above). Consequently, the diagnosis is very easy. Furthermore, the very old cases with considerable malformation of the articular ends of the bones are very easily distinguished from the primary chronic (mon-) arthritis; the author can perhaps best testify to this, for perhaps most of the arthritis cases in Wiesbaden have come under his observation in roentgenograms. In no case should be overlooked the thickening of the distal half of the involved metatarsal, which unqualifiedly belongs to the picture of the disease. Three characteristic roentgenograms are reproduced.

Pathology. At least eight microscopic examinations have been reported, which are more or less detailed. There were found at times necrosis, at times fibrous marrow, at times tissue resembling granulation tissue, thickened cortex, well-preserved cartilage. Fromme found subchondral callus-like tissue with fibrillary connective tissue, fibrous cartilage, hyaline cartilage and osteoid substance; Aschausen observed a great subchondral focus with bone- and marrow-necrosis and calcification, surrounded by a resorption zone with thick leukocyte-free connective tissue, and this surrounded in turn by a bone of reaction; the cartilage itself preserved and also thickened, somewhat necrotic in its deepest part; and finally, villous hyperplasia of the synovialis, and lipping as in arthritis deformans. There were found no signs of rickets, tuberculosis, syphilis, osteomyelitis or the like. A third account may be mentioned here, Professor Goldschmidt's report in the article by Cahen-Brach: "Horizontal sections were made through the capitulum of the second left metatarsal. The region of the bone limited by the articular cartilage and the epiphyseal line showed a profound change: in the spongiosa was found a focus, rather rounded in the section, which reached in a stellate fashion to the boundaries just mentioned. In this focus the bony trabeculae were either absent or represented only by fragments. In their place was a connective-tissue focus, fairly rich in cells, embedding fairly numerous small blood-vessels. At the edges of this focus the connective tissue extended, without any sharp border, into the marrow, which was partly a definite fibrous marrow and partly only remarkable because it was rich in connective tissue. Beneath the articular cartilage the bony trabeculae showed no great changes, though no special stains for bone were used. The changes go with the connective tissue described. On the other hand, in the immediate vicinity of this focus there was a zone at the epiphyseal line which one may well designate as a field of dèbris, i.e., the trabeculae lay in fragments in a space filled with necrotic masses. These masses lay directly upon the granulation- or connective-tissue; no inter-

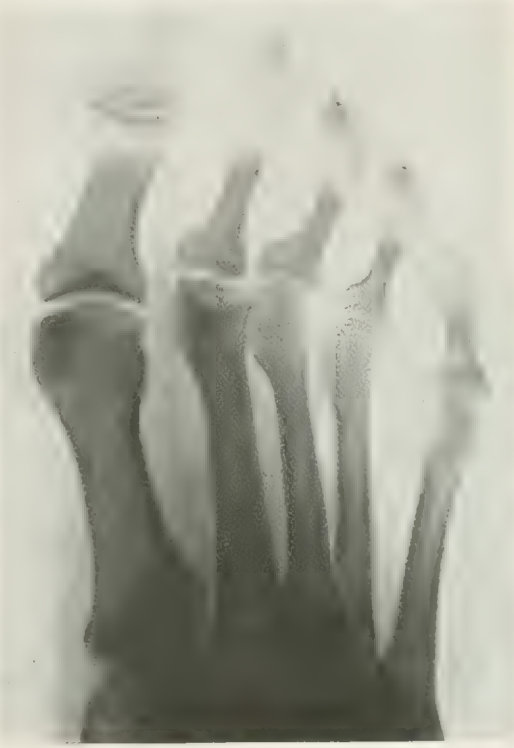


FIG. 2. Another case, more advanced.

nal structure could be recognized. Hemorrhage was not demonstrable, though there were small hemorrhages in the spongiosa on the diaphyseal side of the epiphyseal line. In neither the necrotic zone nor in the connective-tissue foci did I find profound vascular changes, particularly no thromboses. So far as the articular cartilage was examined, no changes were found. In other respects the relation between cartilage and bone was normal for the age of the (female) patient."

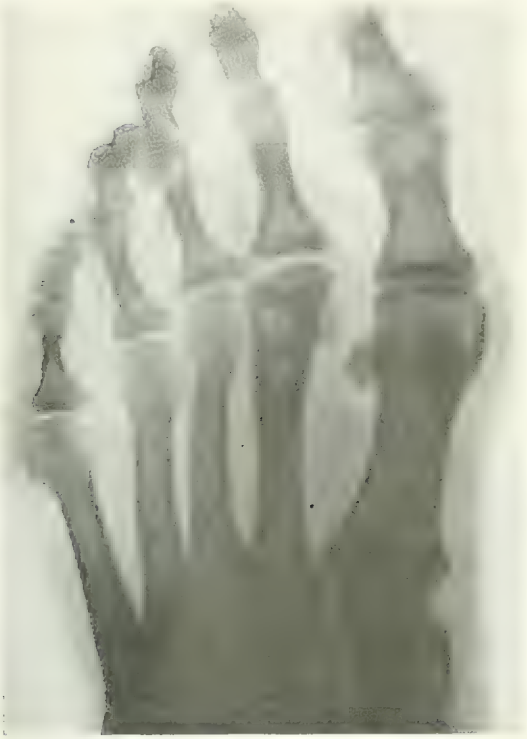


Fig. 3. Another case, of several years' standing, with consecutive arthritis deformans.

Etiology. About 1 patient in 10 gave a history of trauma. We need not dwell further on this point. Certainly trauma alone cannot be the cause. It is much more likely that a barely perceptible mechanical insult, perhaps repeated, is necessary to bring about the clinical manifestation. Against traumatic origin there speak further the slow beginning and the occasional bilateral occurrence of the disease, as well as the histologic and roentgen findings. The points of principal support of the arch on standing on both feet or in walking, according to the investigations of Beely, are the heel and the distal ends of the second and third metatarsals; if the foot is hanging, or if it rests only lightly on its sole, then the distal ends of the first and fifth metatarsals are supports; but if a considerable pressure is placed upon the anterior transverse arch, the arch gives, and the distal ends of the second, third and fourth metatarsals become burdened. In case of flat- or splay-foot the second assumes very much of a burden. In keeping with this, flat-foot appears in the history of many of the patients; and Sonntag found, in 12 cases minutely described, the arch to be normal in only 3, and flat- or splay-feet in 9. However, now that we have 70 cases to study, we find flat-feet in only 1 case in 5 (Cahen-Brach, l.c.). In two or three cases, going barefoot was blamed. In going barefoot one naturally loses the support of the shoe. If there be added a weakness of the connective tissue, which leads to a sinking of the anterior transverse arch, especially of the second metatarsal, the first metatarsal gives medially and when the foot is pronated the principal weight is thrown upon the second. Three cases showed a bowing of the metatarsal upward, as already mentioned. Müller says that the bone is simply reacting to mechanical insults on the same principle that it forms callus after fracture: reaction of the zone of growth; it is pathological only in that the tolerance of the bony tissue to the influences in question is disturbed. Furthermore, the fashionable women's shoes, with their high heels which throw the weight on the fore part of the foot, are responsible for splay-foot so far as etiology goes, and this is in keeping with the fact that the great majority of patients are females. Histologic as well as roentgen findings speak against an inflammatory origin of the disease. As has been already emphasized, no indications of tuberculosis, syphilis, or osteomyelitis were found. (It should be noted, however, that Alberti was able to demonstrate in 4 out of his 6 cases, tuberculosis elsewhere in the body.) Fromme defends the theory that the condition is an osteochondritis of the nature of late rickets. He regards also the Calvé-Legg-Perthes disease of the hip, Schlatter's disease of the tibial protuberance, and the navicular disease which I have described, all as manifestations of the same thing. The thickened and softened cartilage of rickets or late rickets is especially susceptible to traumatic injury. The theory has much in its favor, but in almost all of the patients in question, there were no manifestations whatever of rickets. Yet on the other hand, rachitis tarda is much more frequent than generally appreciated, and clinical signs may be absent. As for this being an inanition-osteopathy, most of the cases were among well-nourished persons. Likewise for its being a deficiency disease. Of the few microscopic studies, there are some descriptions (Aschausen, Kappis, Cahen-Bruck, Herzog, Sonntag) of most peculiar findings in fair agreement, in the form of wedge-shaped necroses of the epiphyses from interruption of nutrition. In 1905 König emphasized, in relation to operative cases of osteochondritis ossificans, that in addition to trauma there must be some other cause operating in an entirely unknown manner, to explain the formation of a sequestrum in a joint lined with cartilage. Thus it is conceived that the cuneiform necrosis of the epiphysis is from embolic-mycotic occlusion of the epiphyseal end-arteries, the mechanical occlusion being the principal consideration. Infection has little or nothing to do with it. However, whether necroses can arise in bones from arterial occlusion has been combated by pathologists (Schmidt). Quite recently Heitzmann and Engel have published microscopic findings to prove the similarity of Perthes' disease and the disease of the metatarsal. Further, Klett believes that he has found histologic evidence of osteitis fibrosa in two of his cases, and is of the opinion that it is concerned in most of the cases if not in all. It is certain that the pathologic-anatomical conception of osteitis fibrosa is still very indefinitely limited.

To sum up: There are anatomic-physiologic reasons for the localization of the disease in the second (or third) metatarsophalangeal articulation. Cases involving the first toe do not belong in this class, but in that of simple chronic arthritis. The second metatarsal is the one most exposed to weight-bearing and various insults, as is indicated by its being much the most frequently involved in the swollen foot of soldiers. This factor however is not self-sufficient for the production of the disease. There must be another pathological factor, a certain debility of the osseous system, perhaps less of an infectious nature than of a toxic, toxic-infectious, or hormonic nature, or a dyscrasia or a diathesis, through which the general resistance of the organism is lowered, to become manifest at the point of greatest strain. Or there may be a predisposition in the sense of a constitutional anomaly, perhaps analogous to the so-called stigmata of degenerations; it is not entirely disproved that phylogenetic considerations play a part.[1] Possibly slight repeated, or even more considerable over-strains lead to a form of osteochondritis-malacia. I myself in my first communication, remarked upon the similarity of the roentgen findings in comparison with osteochondritis dissecans of the knee. There can then develop—though how is still unknown—a great bony necrosis in the epiphysis, as a few scattered microscopic observations testify. In the course of years there occur alterations in the joint in the sense of an arthritis deformans, but easily to be distinguished from that condition by roentgen examination. There can also occur a bowing of the capitulum upward, as a thoroughly studied case showed, in which the microscopic examination showed only normal bone, and cartilage which was normal in the deeper layers, but stained poorly and showed some fibrous degeneration on the surface.

At the 47th Congress of the German Surgical Society, in 1923 in Berlin, no less an authority on pathology than Aschoff of Freiburg stated that our disease is probably the same process as the Calvé-Legg-Perthes disease and the disease of the os lunatum. The essential feature is a subchondral bone-necrosis, which (in the hip) leads to a re-forming of the whole head of the bone without the cartilage being destroyed. Vascular disturbances probably play a rôle in the development of the disease. However, Aschausen is of the opinion that these need not always be emboli. Traumatic strains which lead to an occlusion of the vessels and other factors can cause the disease. From the pathologic standpoint the process is not the same as arthritis deformans. Aschoff does not consider as possible a direct transition from this disease into true arthritis deformans.

---

[1] The author first called attention to this possibility at the Congress of the German Roentgen Ray Society in 1920.

Treatment. Conservative treatment is to be attempted first of all. The foot should be spared as much as possible, and in case of necessity, rest in bed, poultices, baths, heat, hot air, massage, etc., are indicated, as well as supporting bandages; probably the best treatment is a well-fitting shoe with an inlay designed from a plaster-cast; in addition, constitutional treatment, good nourishment, fresh air, sun, cod-liver oil, iron, iodine, arsenic, phosphorus, calcium and organic preparations. Operation is indicated only in patients beyond the growth-period.

By and large, we may say of our disease that much still remains unexplained in its etiology and pathogenesis.

NOTE: In the *Journal of the American Medical Association* for July 21, 1923, which appeared while the foregoing article was in the hands of the printer, is an article entitled "Juvenile Deforming Metatarsophalangeal Osteochondritis—Freiberg's Infraction of the Metatarsal Head" by Dr. Philip Lewin of Chicago, who states that this condition "was first described by Freiberg of Cincinnati in 1913, in a paper read before the Southern Surgical and Gynecological Association. He saw his first case in 1903, but his paper reporting 6 cases did not appear until August, 1914." It was published in *Surgery, Gynecology and Obstetrics.* Editor.

BIBLIOGRAPHY

1. Cahen-Brach. The etiology of Köhler's metatarsal disease. *Arch. f. klin. Chir.*, 1923, cxxiv, No. 1. Partial bibliography.
2. Fromme. Late rickets and osteochondritis. *Verbanal. d. deutsch. Gesellsch. f. Chir.*, 1920, p. 119; also 1921.
3. Fromme. A typical disease of the proximal articulation of the toe. *Zentralbl. f. Chir.*, 1921–22, p. 797.
4. Fromme. Köhler's disease. *Munchen. med. Wchnschr.*, 1922, No. 29, p. 1096.
5. Aschausen. The etiology of Köhler's disease. *Beitr. c. klin. Chir.*, 1922, cxxvi.
6. Alberti. Köhler's syndrome. La Chir. degl. organi di movimento, 1922.
7. Müller. *München. med. Wchnschr.*, 1922, No. 42; also, *Beitr. z. klin. Chir.*, 1922, cxxvii, No. 2.
8. Sonntag. *Deutsche Ztschr. f. Chir.*, 1921, 163; also, *München. med. Wchnschr.*, 1922, No. 45.
9. Klett, W. Beitrag zur Ätiologie die Köhlerschen Erkrankung der Metatarso-Phalangeal-gelenke (Tafel 36).
10. Heitzmann and Engel. *Med. Klin.*, 1923.
11. Schmidt, M. B., in Ludwig Aschoff's textbook, cited by Cahen-Brach.

TWO CASES OF LOCALIZED METASTATIC CARCINOMA OF VERTEBRAE WITHOUT DEMONSTRABLE PRIMARY LESION*

BY CYRIL P. O'BOYLE, M.D.

PHILADELPHIA, PENNSYLVANIA

PRIMARY carcinoma does not occur in bones. Secondary and metastatic carcinomata,[1] however, are among the most frequent disease conditions of the osseous system. According to von Recklinghausen the bones involved are, in order of frequency, the vertebrae, femur (proximal portion), pelvis, ribs, sternum, humerus (proximal portion), the flat, cranial bones, the bones of the leg and the bones of the forearm. Secondary tumors occur in those portions of the bones which are subjected to the greatest pressure and traction.

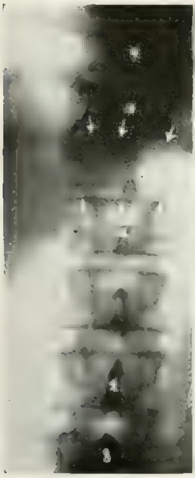


FIG. 1.

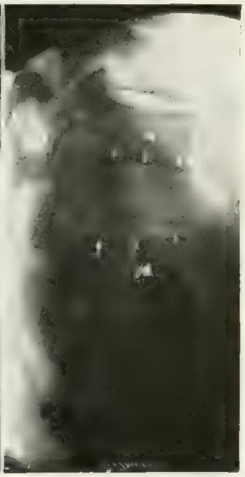


FIG. 2.

FIG. 1. Anteroposterior view of lower thoracic and upper lumber vertebrae. The figures refer to the numbers of the vertebrae (9th to 12th thoracic, 1st to 3rd lumbar). The arrows point to the lesion of the 11th thoracic vertebra, which is a metastatic carcinoma (osteoclastic type). Note the destruction of bone as evidenced by the loss of outline and the compression.

FIG. 2. Lateral view of the same lesion. Compare with Figure 1. Note wedge-shape of 11th thoracic vertebra, due to compression.

The histologic character of the metastatic neoplasms depends more or less on the structural composition of the primary growths. The secondary tumors are sometimes well circumscribed, sometimes infiltrating. According to their behavior they may be divided into osteoclastic (bone-destroying) or osteoplastic (bone-forming) tumors. As a rule, bone destruction and osseous formation coexist, but one or the other may predominate and form the leading character of the tumor. Naturally bone destruction must take place to some extent; the ever-expanding new growth leads to osseous atrophy, lacunar resorption and finally to more or less disintegration. Fractures commonly result, or the diseased bones may become softened and pliable through absorption of their calcium; this is spoken of as carcinomatous osteomalacia. It is to be emphasized that neoplastic osteoclasis rarely involves the bone in a uniform fashion. In the roentgenogram the diseased portions are frequently irregular in outline and have a moth-eaten appearance. Conspicuous shortening of bone occurs when the destructive process is of sufficient width.

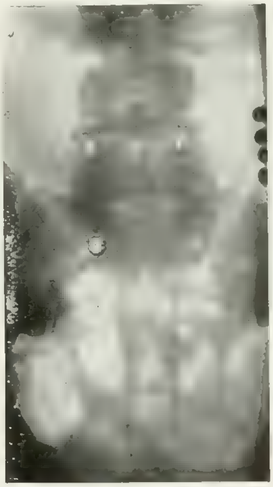


FIG. 3. Anteroposterior view of 3rd to 5th lumbar vertebrae and the sacrum. The arrows point to a metastatic (osteoplastic) carcinoma. Note the increased density of the 5th lumbar vertebra and the upper portion of the sacrum.

In the osteoplastic type of metastatic carcinoma much osteoid or osseous formation occurs. The new bone formation probably takes place through stimulation or increased activity of preserved osteoblasts, the tumor acting as the irritant. It may also be that the irritation and consequent osteoblastic stimulation depend upon occlusion by tumor cells of some of the vessels of the bone. Some of the newly-formed osteoid tissue may also arise through metaplasia of the fibrous stroma of the tumor. In any case the new tissue may remain osteoid for a long period, or it may gradually become very solid, compact and osseous. The osteoplastic property of some tumors is so marked that they may transform some portions of the involved bone into an ivory-hard material. In such cases a roentgen-ray diagnosis is sometimes difficult, and the dense areas may be mistaken for non-neoplastic disease of the bones. In most cases, however, the irregular increase in density and the irregular distribution of the lesions permit a diagnosis to be made.

---

*Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

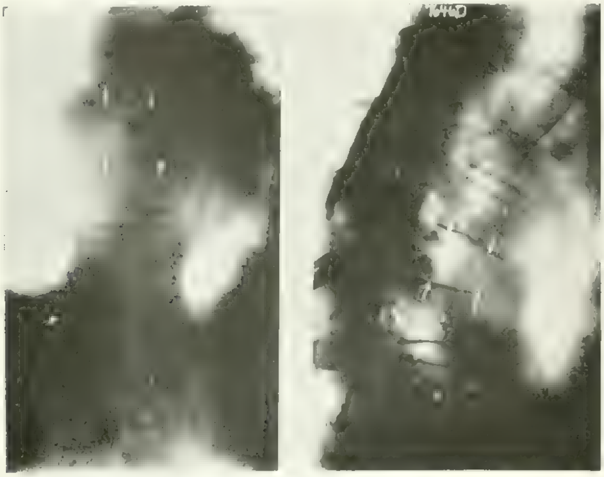


FIG. 4. (a) Anteroposterior view of lower thoracic vertebrae showing a metastatic carcinoma of the 9th thoracic vertebra. (b) Lateral view of same lesion showing compression from carcinomatous bone destruction.[1]

As to the frequency of cancerous metastasis to the bony structures the following figures by Kaufmann are illuminating. His data are based upon the autopsy records of the Pathological Institute in Basle. In 63 cases of carcinoma of the mammary gland, bone metastasis occurred 33 times, or in 52 per cent; and in 24 cases of prostatic cancer, 16 times. But in 309 cases of gastric carcinoma only 2.5 per cent showed bony metastasis; in 159 cases of uterine carcinoma, only 5 per cent; in 101 cases of esophageal carcinoma, 6.9 per cent, and in 57 cases of carcinoma of the rectum, 10.5 per cent. These figures show that the cancers of the mammary gland and of the prostate are particularly liable to produce bone involvement.

In the recent papers by Pfahler (1916) and by Moore (1919) further references to the literature may be found. In two cases summarized below, the vertebral column was the seat of these processes.

CASE I. Male, aged forty-nine, agent by occupation. Admitted to the Misericordia Hospital on Oct. 1, 1920, complaining of pain in the back and left side. The symptoms dated back to May, 1920, when he first experienced sharp pains in the left side, especially on arising in the morning. As the day went on the pains lessened and gradually disappeared. At first the attacks were periodic but they became much aggravated after a game of handball. Often he would awake early in the morning with sharp pains, particularly in the left lumbar region. There was much stiffness of the back and difficulty when attempting to stoop. There has been no headache, no vertigo, no cardiac symptoms. Has been badly constipated for some time; no other gastro-intestinal symptoms. Never had any serious injury. There is nothing of importance in the previous medical history; family history is negative. Laboratory examination revealed nothing of importance. A provisional diagnosis of osteoarthritis of the spine was made and the patient referred to the neurological department.

Here it was found that the patient had much difficulty and pain in making trunk movements. The 11th thoracic vertebra was tender to percussion and strong pressure. The muscular system was negative.

---

[1] The original plates of these photographs were not available, and the reproductions here were made with difficulty from lantern slides.

There was no impairment of the joint, postural and tactile sense. The epigastric, infraabdominal, and cremasteric reflexes could not be elicited. Both patellar reflexes were exaggerated, especially the left. No Babinski; Achilles tendon present. There was an area of distinctly diminished sensibility to pain on right side posteriorly extending from upper border of the buttock to the level of the spine of the 11th thoracic vertebra. On the left side a similar area was found, but it extended almost two inches lower. This area was just below the body of the 11th thoracic vertebra and therefore just below the 12th cord segment. The upper margins would correspond to the level of the spine of the 11th thoracic vertebra. Anteriorly there were irregular areas of hyperesthesia and hypoesthesia from below the umbilicus to above the knee, especially on the left side of the body. The level of the sensory symptoms was therefore fixed to about the 1st and 2nd lumbar cord segments or opposite the 11th thoracic vertebra and the upper margins of the 12th thoracic body.

The history, symptoms and most of the signs point to a left-sided lesion, and to involvement of the posterior roots and perhaps the lateral tracts. Since no paralysis, no bladder symptoms and no important thermic disturbance is present, the amount of cord compression cannot be very great. The character of the lesion is somewhat difficult to decide. Tuberculous caries can be ruled out because of the age and the absence of any primary focus. An intramedullary growth was excluded because the root symptoms were so pronounced at what appears to be an early stage of the disease, there were no trophic changes and the spinal tenderness was present. The pain and difficulty in moving the trunk suggested vertebral disease. Quoting Dr. Edward Strecker, who made the above examination, "In regard to carcinoma I could not bring myself to this diagnosis in the absence of an established primary lesion."

The patient was referred to the roentgenological department on Oct. 4, 1920, where examination revealed destructive disease of the 11th thoracic vertebra, which looks much like metastatic carcinoma of the osteoclastic type. Dr. G. E. Pfahler's report reads: "Total decalcification of 11th thoracic vertebra, while 10th and 12th thoracic vertebrae were perfectly healthy. There seems to be an osteoplastic process of the 5th lumbar vertebra also resembling metastatic carcinoma." These lesions are well shown in Figures 1, 2 and 3.

The primary tumor was searched for unsuccessfully. Operation was decided upon and on Nov. 5, 1920, laminectomy and resection of the posterior roots at the 11th and 12th thoracic vertebrae was performed by Dr. G. P. Muller. Portions of the friable bone were examined histologically. An infiltrating adenocarcinoma was found; the stroma of the tumor was prominent and consisted of dense fibrous tissue and spicules of newly-formed bone. The patient was treated with roentgen rays, but died on Mar. 9, 1921. No autopsy was obtained.

The clinical side of this case has been given in brief since it illustrates a very typical picture of a metastatic carcinoma, the primary focus of which could not be discovered. The pathological examination, concurred in by Drs. Smith and Lucke, confirmed the roentgenological opinion.

Case II. (From Dr. Pfahler's records.) Male, aged seventy-two. About two years ago patient was taken with pain in the right side at a point where the posterior axillary line crosses the 9th and 10th ribs. The pain was inconstant, no difficulty in eating or motion. No jaundice, no radiation of pain to shoulder. Complained also of pain in lower dorsal and upper lumbar regions. During past year suffers only when moving about or when sitting; is free from pain when reclining. Neurological examination at this time negative for osteospinal cord diseases. Urological examination revealed a slightly enlarged round, smooth, movable soft prostatic gland. On roentgenological examination a general carcinomatosis was discovered. There was total destruction of the outer portion of the 9th rib (Fig. 4) and 9th dorsal vertebra, and partial destruction of the 12th thoracic vertebra. The outer portion of the right clavicle and the glenoid cavity of the right scapula were likewise involved, and there were metastatic nodules in the right lung.

This illustrates an extensive metastatic carcinoma of the osteoclastic type; *the primary focus of the tumor could not be discovered.*

SUMMARY

Two cases of metastatic carcinoma of the vertebral column are reported; the primary focus was not demonstrated in either case. The most prominent symptom in the two cases was pain on motion. By roentgenological examination such lesions are usually readily diagnosed, and this should always be employed.

My thanks are due to Dr. G. E. Pfahler, Dr. G. P. Muller, and Dr. E. Strecker for permission to use their data.

BIBLIOGRAPHY

1. v. Recklinghausen. Die fibrose oder deformierende ostitis, die osteomalacie u. d. osteoplastiche carcinose in ibsen gegenseitigen Beziehungen. *Festchr. f. Virchow,* Berlin, 1891.
2. Kaufmann, Edward. Lehrbuch der Speciellen. *Pathologischen Anatomie,* Ed. 2, Berlin, 1911.
3. Pfahler, George. The roentgen diagnosis of metastatic malignant disease of bone, with special reference to the spinal column. Am. J. Roentgenol., Mar., 1917, iv, 114.
4. Moore, A. B. A roentgenologic study of metastatic malignancy of the bones. Am. J. Roentgenol., Dec., 1919, vi, 589.

HYPERNEPHROMA*

BY HARRY B. PODLASKY, M.D.

Associate Professor, Department of Roentgenology, Marquette University; Director, Roentgenological Laboratory, Mt. Sinai Hospital

MILWAUKEE, WISCONSIN

DURING the past year two cases of hypernephroma were observed in the roentgenological service of Mt. Sinai Hospital. Reports of similar cases have appeared recently in the *Surgical Clinic, Chicago.* The literature upon the subject is abundant, yet the writer was prompted to review it, in order to call attention to the importance and significance of chest examination in cases of hypernephroma, and to stimulate observation as to the beneficial effects from the employment of *x*-ray therapy, as has been suggested by well-known men.

An idea as to the prevalence of hypernephromata may be gathered from the following table:

Kidney Tumors (Hyman)

	Kidney Tumors	Hypernephromata	Others
Israel	126	86	40
Albrecht	32	28	4
Barney	114	43	71
Boston City and Massachusetts General Hospitals	42	33	9
Mayo Clinic, 1911	56	36	20
Mt. Sinai Hospital, N. Y. City, A. A. Berg	38	36	2
Pleschner	35	25	10
Hyman	40	28	12

In approaching this subject one is immediately impressed with the varied and complicated views held in regard to the pathology of hypernephroma. Although the theory of Grawitz, first accurately described by him in 1883,[1] regarding it as a tumor composed of aberrant adrenal tissue, has been largely accepted, there are other interesting theories that one may mention.

Grawitz called the tumor "Struma lipomatodes aberratae renis," and in 1894 Lubarsch suggested the name of hypernephroma. It is claimed, however, that the latter name was suggested by Birch-Hirschfeld, in 1896. Duffield, in 1909, applied the name of hypernephroma to any growth arising from adrenal cells, whether the growth was adenoma, carcinoma, or sarcoma.

The pathology, not only, is doubtful, but even the opinions as to what portion of the kidney is most often involved, seem to be at extremes. For example, in Murphy's case he states, "If hypernephromata arise from adrenal rests it is surprising and difficult to explain why they practically always arise in the lower two-thirds of the kidney, and almost never in the upper third, which lies so much closer to the adrenal gland."

---

* Paper submitted leading to membership in The American Roentgen Ray Society, 1921.

The contrary view is expressed by Hugh Hampton Young: "The occurrence of adrenal rests has been the subject of considerable study. Imbert found them in different organs in 92 out of 100 autopsies; in the kidney in 8 per cent of the cases. They are usually found in the upper pole beneath the capsule, and this is the usual site for hypernephromata."

Hyman states that the theory of location most frequently quoted as being in the upper pole has been disproved, and that it is more often found in the center or lower pole. This latter corresponds to the opinions of several surgeons personally questioned, that hypernephroma may occur almost anywhere in the kidney.

More interesting is the expression of opinion as to origin of these tumors. Stoerck, of Vienna, believes that "hypernephromata arise in the course of a chronic nephritis; that when a group of urinary tubules is destroyed, regeneration takes place from the remaining tubule stumps, and overregeneration—a well-known biologic phenomenon, seen under many different and curious conditions—sometimes occurs with adenoma formations; and from these adenomata, hypernephromata [or carcinomata, as Stoerck calls them] may develop." Stoerck's theory has obtained a great following because of the large number of accurately observed cases on which it is based, the great scientific reputation and the enormous pathologic experience of Professor Stoerck. Many of Stoerck's co-workers still adhere, however, to Grawitz's original view that these tumors start from misplaced adrenal rests. Murphy states further: "I, myself, have seen a specimen of a large hypernephroma at the upper pole of the kidney, as in the case of today where the adrenal on the same side was entirely missing. The presumption was very attractive in that case that the adrenal had been misplaced into the upper pole of the kidney by some embryonic perversity, and had furnished the starting point of the hypernephroma."

Adami believes they are of renal origin also, but that they arise from proliferating islets of nephrogenic tissue (mesoblast) derived from fetal Wolffian ducts which have never become connected with renal tubules. Therefore, Adami calls these tumors mesotheliomata instead of hypernephromata. Wilson, according to Hyman, has also advanced this theory:

"Accessory adrenals are common. They are known as adrenal rests. They are found most often in the connective tissue about the main adrenals, but also in the kidneys, right lobe of the liver, along the renal vessels, spermatic veins in the inguinal canals and in the broad ligaments."[2] In Hyman's article, previously referred to, he mentions a case of primary hypernephroma of the tongue reported by Coeneus.[3]

W. W. Keen, in 163 cases, found 157 in the kidney, 3 in the adrenal, 2 in the liver, and 1 in the uterus. Young amputated a leg for sarcoma which, upon microscopic examination, showed hypernephroma. There was no sign of kidney tumor in this case.

The period of life during which these tumors are the most prevalent appears to be from forty to sixty years. The male seems more prone to the disease than the female. Heredity appears to play no part in this condition. The literature gives no definite evidence of trauma as a causative factor, although Hyman states that "twice positively the tumor was observed after trauma."

The small hypernephromata are usually very similar in histological arrangement to adrenal tissue. The cells are seen in rows resting upon capillaries which make up the stroma. These cells are larger than adrenals and are polygonal in shape. They contain a great deal of fat, and upon chemical examination show lecithin and glycogen.

Hypernephroma may begin as a very small nodule in the kidney and gradually invade it until almost the entire kidney substance is replaced. Adjoining structures are not commonly invaded. Invasion by lymphatics is doubted; systemic invasion is usually through the blood stream. The renal veins are often invaded by the tumor. It is claimed by Murphy that operative results are much better where neither the renal veins or vena cava are invaded at time of operation. Loosened emboli are carried great distances through the circulation. Metastases have been found in the brain, bronchi, diaphragm, heart, liver, intestines, omentum, pancreas, pleura, peritoneum, skin, uterus, urethra and various portions of the bony skeleton. There appears, however, no case on record where the ureter has been involved. This despite the fact that the tumor may grow out into the renal pelvis. (Young.)

The symptomatology of hypernephroma is as variable as its growth and pathology. The three outstanding symptoms are hematuria, pain and tumor mass. Hematuria is observed in from 50 to 70 per cent of cases. This corresponds with Bevan's observation that in about 50 per cent of cases there are no urinary findings whatever. Pain occurring before bleeding is rare. Bleeding occurs at irregular intervals. In one of Israel's cases there was hematuria for twelve years. Hematuria does not appear to be influenced by occupation or position. Frequent hemorrhages do not necessarily mean an operation as a life-saving measure.

Pain may be the first symptom, but it may be absent for a long period. A tumor mass very often reaches great size without pain. There may be only a dull ache, and at times pain may follow the course of the sacral and pelvic nerves. When the ureters are blocked by blood clots, pain becomes colicky in character, simulating renal colic.

Some of the tumors are almost impossible to elicit by palpation, particularly when they involve the upper pole of the kidneys. A palpable tumor of the flank is one of the most important symptoms. The growth may not distort the outline of the kidney. These tumors are present in a large number of cases that come to the operating table.

In Hyman's summary of these three cardinal symptoms, he places great stress on the extreme degree of variability, and hence the great difficulty in establishing an early diagnosis of hypernephroma.

Among other symptoms may be mentioned the occurrence of a right-sided varicocele, first noted by Guyon. Symptoms may also be due to compression of abdominal viscera, such as jaundice, edema and ascites. Gastric symptoms such as nausea, vomiting and hematemesis may also offer a very distressing complication.

The methods to be employed in arriving at a diagnosis, or at least offering valuable aid, are pyelography, cystoscopic examination and tests for renal function. The above constitutes the plan followed when patients finally reach the hospital, presumably for operation. It is very often at this time that the first *x*-ray examination of the chest is made. The reason for this is that by this time metastasis is expected, and the authorities seem to agree that in the presence of chest involvement operation is useless.

Bevan, Murphy, and Eisendrath speak of the importance, and emphasize the value of, roentgenograms and roentgen therapy. Eisendrath informs us that metastases into the lungs are produced very early. Murphy and Bevan have urged the employment of *x*-ray therapy in inoperable cases and as a postoperative measure, claiming beneficial results. It is well known at the present time that metastatic areas must also receive treatment as well as the original site of the lesion. Murphy is of the opinion that early application of irradiation is more beneficial than when recurrence has taken place. Patients have been kept comfortable from three to five years. This compares favorably with the results obtained by surgery.

The question as to whether or not hypernephromata are malignant tumors has not been settled. Keen says that for practical purposes a solid tumor of the kidney is malignant.

Keyes tells us that hypernephromata may be benign or malignant; the benign type has a marked tendency to become malignant. Murphy emphatically states that he considered it a malignant tumor irrespective of pathological disputes.

Garceau, according to Young, found the duration of this disease in a series of 27 cases to cover periods of from three to twelve years. In another series of 89 cases, the duration was not over a few months. In 21 cases where metastasis was present, only 4 cases lasted more than one year. He states that metastases in bones and lungs were of more importance than the actual presence of the renal tumor.

In view of the fact that this type of tumor is considered by practically all to be malignant in character, an early diagnosis is imperative. Procrastination is particularly dangerous, according to Stoerck (quoted in Hyman's article[4]) if the course of the disease can be explained by the pathological anatomy of this tumor. Stoerck gives two divisions; benign and malignant forms of the tumor. In the benign form, "the tumor is sharply encapsulated from the surrounding kidney tissue; the latter are the growths which may be present for years without causing symptoms. In the malignant type, the tumor breaks through the capsule and metastasis occurs." It is wholly desirable to interpret this condition correctly at the very earliest possible moment, or in the stage to which the term "transitional" might be applied,

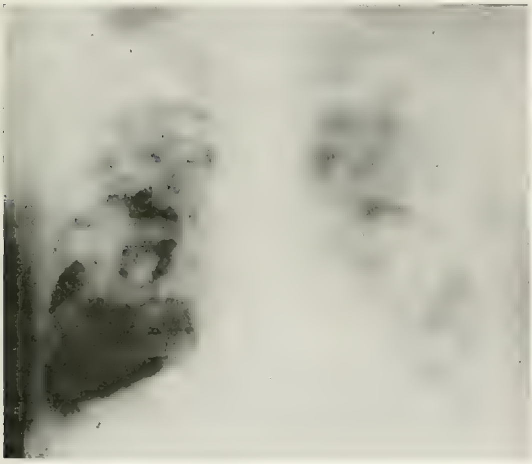


Fig. 1. Key plate. Metastatic nodules in chest one year after removal of testicle for sarcoma.

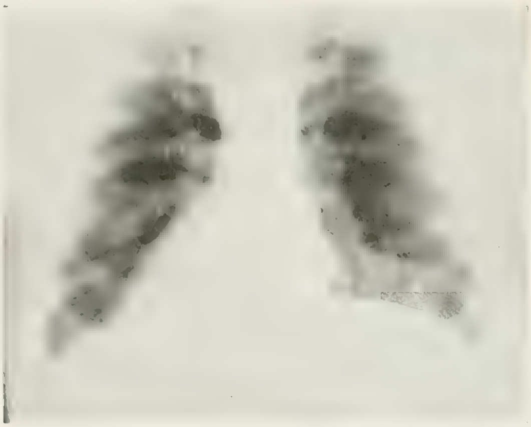


Fig. 2. Case II. The lower lung fields, bilateral, show the nodules, less dense than those found in key plate.

In 1916, Moore and Carman wrote describing the nodular form of lung metastasis, and showed five prints dealing with metastatic areas in the lung from cancer of the breast, stomach and uterus.

The writer has not been able to find any publication in which there appears an illustration showing even one phase of the metastasis of hypernephroma. It was therefore thought advisable to insert these prints.

Moore and Carman report 71 cases of lung metastasis giving 5 cases originating from the kidney, three of which were operated upon, two proving to be "hypernephroma" and one, carcinoma. In their conclusions they stated that roentgenographic examination should be made as a routine, and thus many patients saved from useless surgery.

Hyman does not concede the efficacy of radium or *x*-ray therapy as compared with nephrectomy, wherever possible. However, the early recognition of chest involvement is very important. For although the tumor of the kidney may be extirpated, the metastatic process must obviously be taken care of in some other way. It would be logical to suppose that roentgen therapy would be applied to these very cases.

Holding, in 1916, as well as others, urged the employment of roentgen therapy for the "ameliorating" effects in lung tumors. It would be of great interest to know whether this method has been satisfactorily investigated in connection with lung and bone metastases in the larger clinics of this country. The writer has not had the opportunity to employ this procedure. It is true that postoperative cases are frequently referred for treatment; but what of the inoperable cases about which a large amount of skepticism as to the efficacy of roentgen treatment still remains?

Pfahler's statement in The American Journal of Roentgenology published in November, 1919, p. 576, emphasized the importance of chest examination. The infiltrating type was described in a case of hypernephroma referred for postoperative *x*-ray therapy. Dr. Pfahler made a chest examination "where there was no thought on the part of others as to recurrence or metastasis," owing to the patient's generally good condition. He differentiated this infiltration from the infiltrating type of tuberculosis.

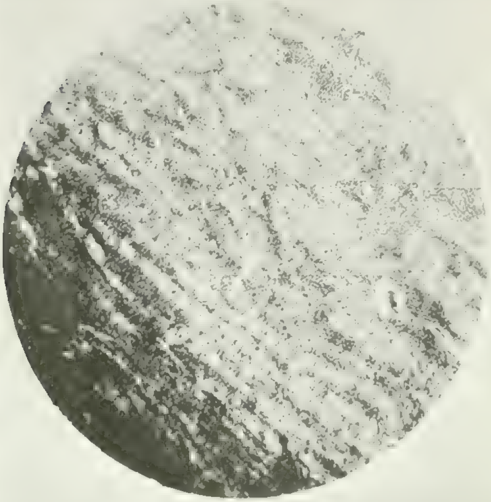


Fig. 3. Case I. Lower power. Adrenal carcinoma. Striated areas of tumor cells.

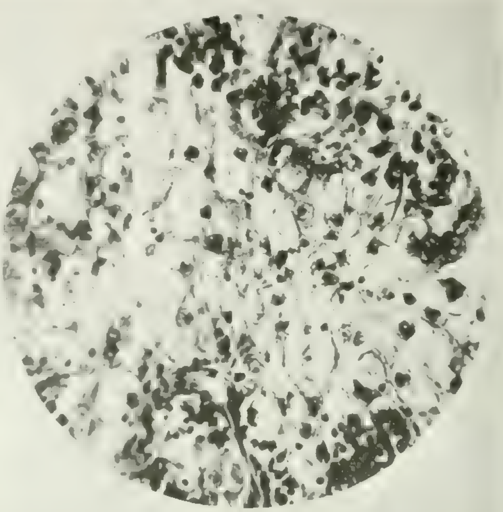


Fig. 4. Case I. High power. Adrenal carcinoma. Hyaline cells.

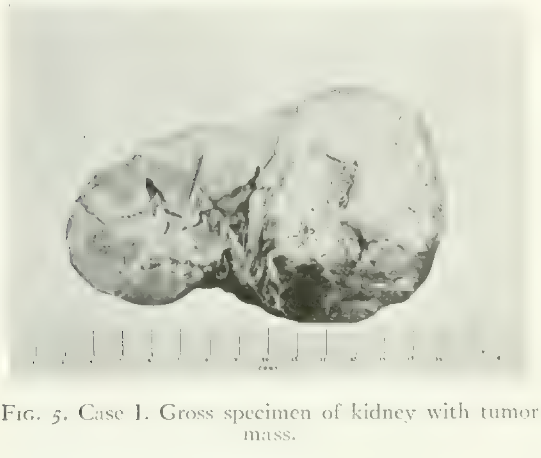


Fig. 5. Case I. Gross specimen of kidney with tumor mass.

The two cases to be reported in this article show the nodular type which corresponds to the description in Pfahler's paper under the nodular type of metastatic carcinoma of the lungs. It will be observed that nodules are multiple in character, quite discrete and distinct in border outline, although of varying size and density. The nodules are not limited to the hilus region, but can be seen in the parenchyma and just underneath the clavicle as well.

The following case reports are rather typical of the varied symptomatology of hypernephroma. It is unfortunate that the findings in both cases were not definitely corroborated by post-mortem findings. In Case II, the diagnosis of tuberculosis was made by several consultants previous to and after *x*-ray examination of the chest, despite the protests of the roentgen department that this was a case of secondary involvement of the chest, which was subsequently borne out by the facts in the case.

The first case was proved after the kidney had been extirpated, the specimens of which are shown in illustrations accompanying this article. In the latter case the symptomatology was more or less classical, and the diagnosis was clinically suspected. The chest plate in the latter case showed the metastatic areas largely within the hilus region, whereas in the former case the metastasis was throughout both lungs, and was parenchymal in character.

I am greatly indebted to Dr. Barta, of

Marquette University, for the pathological specimens and illustrations.

CASE I. Male. Admitted Nov. 16, 1920. Operated upon Nov. 18, 1920. Died Nov. 19, 1920.

Present Complaint. Pain in the right side of abdomen. Flow of blood from urethra, general weakness.

Onset and Course. His pain started last March in the right side. This pain was indefinite at first. It seemed to trouble him most while he was at work. The pain became gradually more severe. It radiated downward toward the pubis. In July, he noticed blood in the urine which had increased in the last two months. During the last few days the blood flow had been almost continuous. He urinated once or twice at night for the past several years. He had not worked during the past two months and felt weak. He lost weight in the early months but regained it.

Past Illness. Appendectomy eleven years ago.

Family History. Mother and father died of old age. No history of malignancy or tuberculosis in the family. Venereal history denied.

General. Appetite fair, bowels regular, no headache, no other pain, ankles never swell, no vertigo, no cough.

Physical Examination. Head. Pupils equal and react to light and accommodation. Teeth in poor condition. Neck shows no enlargement over thyroid, no pulsating vessels. Chest. Symmetrical and expansion equal. Lungs—Breath sounds clear. No areas of dulness, no rales. Heart—Cardiac dulness not enlarged. Apex beat in 5th interspace in nipple line. No murmurs.

Abdomen. Firm and rounded. Liver not enlarged. No tenderness or rigidity. Large mass, palpable in region of right kidney. Extremities—No impairment of function. Reflexes present and normal.

Cystoscopic Examination. Blood clots in bladder. Turbid urine from right ureter; clear urine from left ureter. Indigo-carmine test appears in left ureter in seven minutes. No evidence in fifteen minutes from right ureter. Examination of urine, right ureter, leucocytes, a few colon bacilli, large amount of blood.

Laboratory Findings. Urine, sp. gr. 1:010 acid in reaction, sugar negative, albumen positive, red blood-cells abundant, leucocytes increased.

Blood. Red blood-cells 3,160,000. Hbg. 75 per cent. Color index 1. White blood-cells 6,200. Polymorphonuclear, neutrophiles 75 per cent. Large and small lymphocytes 24 per cent. Endothelial leucocytes 1 per cent. Appearance of erythrocytes normal in shape and size. Wassermann negative.

X-ray Findings. Nodular metastatic involvement in the right side of chest in the region of the hilus.

Pathological Diagnosis. Adrenal carcinoma.

CASE II. Male, aged forty-nine. Admitted to Mt. Sinai Hospital, Nov. 10, 1919. Discharged Nov. 23, 1919.

Reason for admission to hospital was the sudden expectoration of blood the night previous to admission. Bloody expectoration continued at intervals since that time. It was not foamy and did not always appear bright red in color. Absolutely denied previous similar attacks. No pain anywhere in the body. No chill at any time. No previous or present cough.

General History. Not subject to headaches, no sore throat, no dyspnea. Has not lost weight for the last four years. Did not catch cold frequently. Feels strong. Appetite very good. No vomiting or pain in epigastrium after eating. No genitourinary diseases.

Past History. No sickness since childhood; no operations. Habits—Indoor work of an executive character, moderate amount of tobacco. No alcohol in the last few years. Meals regular and rests well at night. Venereal—Gonorrhea about twenty-five years ago. He is not married.

Physical Examination. Patient quiet in bed, and in no discomfort, color of mucous membranes good. Not nervous, cheeks slightly flushed.

Head. Eyes, nose, ears were all negative. Mouth—Tonsils large, tongue coated, teeth showed excessive dental work. Neck—Negative.

Chest. Lungs negative, except blowing respiration over a small area on right side of chest anteriorly about level of 3rd rib, mid-clavicular line, also slight impairment to percussion and lessened breath sounds in right apex posteriorly.

Heart. Negative.

Abdomen. Negative.

Extremities. Musculature good. No evidence of emaciation anywhere. Knee-jerks present and active.

No reaction to 5 mg. of old tuberculin subcutaneous injection. Wassermann negative.

Nov. 20, 1919. Examination of chest revealed narrow Kroenig's isthmus left side as compared with right side. Lessened expansion of left base posteriorly. No impaired resonance or rales. Respiration normal throughout.

Daily examination of sputum showed no evidence of bacilli of tuberculosis, but traces of blood.

Temperature on admission was 100.4° F., pulse 110. respiration 22.

Urine Analysis. Negative.

Blood. Red blood-cells 3,220,000. Hbg. 75 per cent. Color index 1. White blood-cells 5,050. Polymorphonuclear neutrophiles 77 per cent. Basophiles 2 per cent. Eosinophiles 4 per cent. Large lymphocytes 14 per cent. Small lymphocytes 2 per cent. Endothelial leucocytes 1 per cent. Appearance of erythrocytes, marked variation in shape and size.

Patient discharged in good condition. Re-admitted to hospital May 24, 1920, having passed a large amount of blood during urination. Physical examination practically as before, excepting that patient was very much emaciated. Remained in the hospital until the date of death, July 14, 1920. Condition grew steadily worse from day to day and emaciation was very rapid. Appearance at time of death was more or less characteristic of the cachexia due to malignancy.

BIBLIOGRAPHY

1. *Virchow's Arch. f. path. Anat.*, xciii.
2. Da Costa. Surgery, Ed. 7. Philadelphia, 1919.
3. *Berl. klin.-therap. Wchnschr.*, 1914, xxxvii.
4. Hyman. Tumors of the kidney. *Surg., Gynec. & Obst.*, March, 1921, xxxii, 216.
5. Young, H. H. Tumors of the Kidney. Osler's Modern Medicine. Philadelphia and New York, 1909, vi, 297.
6. Murphy, J. B. Hypernephroma of the Right Kidney. Murphy's Clinics. Philadelphia, June, 1915, iv, 535
7. Adami. Principles of Pathology. Philadelphia and New York, 1909, i, 745.
8. Wilson. *J. Med. Research*, 1911, p. 73.
9. Bevan, A. D. Clinic of Arthur Dean Bevan—Hypernephroma. *Surg. Clin.*, Dec., 1920, iv, 1115.
10. Eisendrath, D. N. Clinic of Daniel N. Eisendrath. Congenital cystic disease of the kidney: consideration of tumors of the kidney in general. *Surg. Clin.*, Oct., 1919, iii, 1057
11. Ransohoff, J. Surgery of the Kidney, the Ureter, and the Suprarenal Gland. Keen's Surgery. Philadelphia, 1910, iv, 244.
12. Keyes, E. L. Diseases of the Genito-Urinary Organs. New York, 1911.
13 Pfahler, G. E. Malignant disease of the lungs, its early recognition and progressive development, as studied by the roentgen rays. Am. J. Roentgenol., Nov., 1919, vi, 575.
14. Moore, A. B., and Carman, R. D. Radiographic diagnosis of metastatic pulmonary malignancy. Am. J. Roentgenol., March, 1916, iii, 126.

ROENTGENOGRAPHIC INTERPRETATION OF ILEOCOLONIC STASIS*

BY ERNEST CHARLES SAMUEL, M.D.

Roentgen Ray Department, Touro Infirmary

NEW ORLEANS, LOUISIANA

THE finding of large quantities of the opaque meal in the ileum, cecum and ascending colon after a brisk purgation with one of the saline group or other popular laxatives must make us realize that there can be considerable stasis with regular bowel movements of once or twice a day. This fact has been proved to our entire satisfaction in our service at Touro Infirmary, with the cooperation of Dr. S. K. Simon, the head of the gastrointestinal division. The ileum and first portion of the large intestine up to the splenic flexure are developed from the mid-gut, the terminal section coming from the hind gut; and this development probably plays some part in the pathology of intestinal stasis.

Roentgenological study has shown us that the mass movement of the feces is initiated in the cecum and proceeds in regular rhythmic waves toward the anus. These waves are quite feeble in the first segment of the colon and to a limited extent are opposed by antiperistaltic waves; from the splenic flexure to the sigmoid, the waves are stronger and more uniform, carrying the hardened feces to the pelvic colon, to be expelled later. When through any cause this movement is interfered with, a distinct pathological condition is the result, with an absorption of the toxic products in the ileum and ascending colon, and its resulting long train of symptoms. We have had enough cases go to operation to prove that in most instances that have had no previous interference, the stasis is probably not due to the congenital bands that were first brought forcibly to our attention by Mr. Lane of England, and by Coffey and Jackson in this country.

We place no value on a simple six-hour retention in the ileum and cecum, but a twenty-four- forty-eight- or seventy-two-hour stasis is reported to the clinician as right-sided stasis. We must determine the cause of the pathology: whether the impediment in the flow of the fecal current is due to a mechanical cause, loss of tone, a chronic appendix, a chronic gall-bladder (with or without adhesions) or adhesions from pelvic inflammation and peritonitis, especially of the tuberculous type. We cannot consider malignancy of the bowel, as this is a true obstruction of the lumen. In one instance, the cause of stasis was an enterolith in the ascending colon. Lack of physical exercise, long-standing chronic disease, and chronic toxemic conditions all play a part in this syndrome.

The patient is usually referred for right-sided pain, and in a large number of cases one is informed by the clinician that the appendix or gall-bladder has been removed for the same pain from which the patient is now suffering. There was relief for a while, due to the forced rest following a laparotomy, to the diet, and above all, attention to the bowels; but the patient now has a return of symptoms and sometimes is much worse than before. The case is gone over in our department. All gastrointestinal observations are made in the erect position whenever possible: only for the sake of testing the mobility of the ileum and cecum and the degree of prolapse of the large bowel, are the observations made recumbent. An observation is made in six hours, repeated in twenty-four, a purgative is then given and another observation made in forty-eight hours. If the barium is still present, another purgative is given and a seventy-two-hour observation made. It is at this time I wish to say a word about purgatives—after we have seen, in the hospital routine following a gastrointestinal examination, one of the saline group given, with a notation on the chart of five or six watery stools, when the roentgenogram will show almost the entire meal still retained, as at the previous examination.

I think the saline group is productive of more harm than good. The fecal current is only stirred up, large quantities of water are drained from the tissues, the bacteria are more active and generally the patient feels much worse following such a purgative. Castor-oil in tablespoonful doses apparently moves the opaque bolus along better, but the resulting constipation to some patients is quite annoying. Large doses of the cascara and phenolphthalein group do very well, but I think they are considered quite irritating to the kidneys.

---

* Read at the Midwinter Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

The fate of the patient depends largely upon whether the surgeon or the internist refers the case. Our report shows marked intestinal stasis with a Lane's kink with prolapse and acute angulation of the large bowel in the region of the hepatic flexure. If the case is in the hands of the surgeon and he decides to operate under anesthetic with the patient recumbent (remember the observations were made in the erect position) the abdomen is opened, the colon is found in place, due to the relaxation from the anesthetic, the only pathology present is the Lane's kink, and, as a consequence, the roentgenologist is criticized for his opinion. It is here I wish to emphasize that I think intestinal stasis belongs to the domain of the gastroenterologist; and I think we as roentgenologists should insist on the medical side of treatment. Every one of us has lived through the time when on reporting a prolapse of the stomach or large bowel, they were surgically suspended, and the patient returned with the same train of symptoms and in a large percentage of cases much worse than before. We rarely see this today, thanks to the cooperation of the internist and roentgenologist. The finding of a filled appendix which empties and is freely movable is no indication that it should be removed; this is merely a part of the symptom complex of the condition, and removal will do no good.

In this paper, which is only preliminary, I simply wish to bring the subject of intestinal stasis forcibly to your attention, as I think we have been lax in not paying sufficient attention to it in our reports. There is very little to be found on this subject in our literature, although quite a bit on the surgical and medical side, and the roentgenologist must be the final judge of the condition.

A PLEA FOR THE USE OF THE ROENTGENOSCOPE IN THE DIAGNOSIS OF URINARY CALCULI*

BY J. L. TABB, M.D.

RICHMOND, VIRGINIA

IT IS a frequent occurrence that a patient is referred to a roentgenologist for an examination for urinary calculus, and he finds a vague shadow, which may or may not be due to a stone. It is with no little embarrassment then that he is forced to tell the referring physician that the patient may or may not have a urinary calculus.

It is in the interpretation of these vague shadows that we have found the roentgenoscope to be of the greatest value, when used in conjunction with the opaque ureteral catheter in place, and the visualizing of the bromide solution during the injection of the kidney pelvis and ureter. It is surprising how small a calculus may be and yet show under the roentgenoscope, provided you already know just where to look for it; the approximate location, of course, having been ascertained from a previous plate.

The technique that we employ is as follows: A leaded ureteral catheter is introduced on the suspected side of the patient, and is preferably passed until the kidney pelvis is reached or until it meets an obstruction. The roentgenoscopic examination is begun, and knowing the approximate location of the suspicious shadow, we make a search for it in this region, using a very small beam of *x*-rays. The shadow can usually be found, particularly if the roentgenologist has waited for the pupils of his eyes to become dilated. I cannot emphasize this point too strongly.

If the shadow is not in the region of the pelvis of the kidney and is not in close proximity to the leaded catheter, it is certainly not a urinary calculus. Often the shadow will be superimposed upon that of the catheter and by rotating the patient the shadow may be thrown well away from the catheter, thus disproving a calculus; whereas if a plate had been made, the shadow would have been superimposed upon the bromide catheter or shadow, and the roentgenologist would have been forced to rely upon the mechanical effects of the stone on the ureter, such as dilatation, which is often uncertain. If by rotating the patient the shadow cannot be thrown away from the catheter at all, the concretion is definitely in the ureter. Besides, the parallax method of location will show that the catheter and shadow are in the same plane, and palpation of the abdomen will move both in unison. If by rotating the patient the shadow can be thrown only a short distance away from the catheter, the catheter should be withdrawn to a point below the shadow and bromide solution injected. In some cases in which a calculus has formed a pocket in the ureter, the solution may be seen to run to the shadow; if, however, it is not seen to do so, a plate should be made, since a small thread of bromide solution running to the calculus may escape detection under the roentgenoscope, but will be easily seen on the plate.

---

* Paper submitted with application for membership in The American Roentgen Ray Society, 1921.

Often the leaded catheter meets an obstruction, and in these cases the catheter may be seen pointing directly toward the calculus. By using the parallax method the shadow and tip of the catheter are found to be in exactly the same plane. The abdomen may be palpated and any difference in movement noticed so that one is rarely in doubt. In shadows close to the ureteral orifice rotation of the patient is not of much avail, unless the patient is extremely thin, since the thickness of the hips and the ossa innominata obscure the view when the patient is in the oblique position. The parallax method, however, will show the catheter and concretion to be in the same plane, and palpation per rectum or vagina will fail to change this position.

The foregoing applies chiefly to the diagnosis of suspicious shadows along the course of the ureter. Now a word as to the diagnosis of shadows in the region of the pelvis of the kidney. It is very obvious that a concretion in the pelvis of the kidney may be at some distance from the catheter, this distance depending upon which calyx the concretion is in, the height to which the catheter has been introduced, and the shape and size of the kidney pelvis. The parallax method may also show that the catheter and concretion are not in the same plane, but on deep inspiration they will move in unison. When the abdomen or lumbar region is palpated the relative position will not be materially altered. These two points are of great value in the differential diagnosis of biliary and renal calculi, since the gallbladder makes a more extensive respiratory excursion than the kidney, and it is freely movable on palpation of the anterior abdominal wall.

After observing these facts and viewing the patient from different angles, the bromide solution is allowed to flow very slowly into the kidney pelvis. The solution may be seen to surround or run to the concretion, and while the solution is slowly filling the pelvis, the patient is rotated and palpation is used. It is often the case, where a pyelogram alone has been made, that the bromide solution completely obscures the calculus. Unless the shape of the kidney pelvis is materially altered, it is difficult to say whether the concretion is in the pelvis or simply in anteroposterior alignment with the bromide shadow. By using the roentgenoscopic method this difficulty is overcome, as the density of the shadow caused by the bromide solution gradually increases, and while the concretion is still visible through the solution, the patient may be rotated and palpation used.

If the calculus is in the cortex of the kidney, of course the bromide solution will not reach it, but the concretion and the bromide shadow should move in unison on deep inspiration and on palpation, and the parallax method will roughly show that the difference in their relative horizontal planes is not greater than the thickness of the normal kidney. There are cases, however, in which suspicious shadows cannot be detected upon roentgenoscopic examination, but these are very few, and in the cases where the concretion may be seen the information afforded by the roentgenoscope has been of such great assistance that at present we employ this method as a routine. I may also say that even in cases where the injection of bromide solution is done for other reasons than the diagnosis of a calculus, we invariably watch the filling of the kidney pelvis and ureter by roentgenoscopic observation.

We use approximately the same milliamperage and spark-gap that we use in ordinary roentgenoscopic examinations of the gastrointestinal tract, namely, 3 ma. and a 5½ in. gap on a rheostate setting, and by regulating the Coolidge control the penetration and milliamperage may be varied inversely.

REPORT OF RESULTS OF X-RAY TREATMENT IN PYORRHEA ALVEOLARIS*

BY G. VON POSWIK, M.D.

SCRANTON, PENNSYLVANIA

WHILE listening to Dr. Hickey, last September, in Washington, reporting results in treating diphtheria carriers and producing negative bacteriology findings within the course of a few hours, the happy thought struck me, that pyorrhea alveolaris might be treated by roentgen rays. As far as we know, there is no curative treatment for pyorrhea. We do not know the exact etiology of that disease, hence all the local and systemic treatments have shown only temporary relief.

The study of oral sepsis is a branch in medicine which has come into prominence during the last few years. The ancient Egyptians knew how to take care of their carious teeth. They replaced lost teeth by gold ones, filled cavities, and even straightened teeth by wire arrangements. The evidence of their skill is found on paintings and also in the mummies which have been exhumed, but there is no evidence of treating pyorrhea.

Is pyorrhea alveolaris caused by heredity? Is it a systemic condition, or are local causes responsible for it? Is it a combination of systemic and local causes?

Pyorrhea may be found where otherwise perfect teeth are present. Bass and Johns of Tulane University thought surely they had found the cause when they demonstrated the fusiform bacillus and Entameba buccalis in the mouths of patients who suffered from amebic dysentery. They based their statements on their experience with the employes who constructed the Panama Canal. Many of then contracted amebic dysentery and the fusiform bacillus and Entameba buccalis were found around the alveoli and in the stools.

Tartar formation is the most prominent symptom. Proper scaling and medicinal applications give relief, but do not effect a cure.

Now what can *x*-ray treatment do? I submit 3 cases, each of a different type, with a prompt clinical result within a short period of time.

Case I. Female, fifty-seven years old, suffering with intercostal neuralgia and indigestion. She vomits at times, is very nervous, has headaches, and appears to be anemic; had typhoid and the menopause when thirty-three. She had given birth to eight children. Family history was negative. The oral findings are as follows: An upper artificial plate, in the lower jaw some of the molars were extracted. The rest of the teeth were loose. The gums were swollen and spongy, bleeding when touched. On pressure, pus came forth. She informed me that these teeth must come out, as all were loose. She received her first treatment on October 8th. On October 25th, the gums were still somewhat swollen, but there was no pus. Some of the teeth were beginning to tighten. Treatment given. On November 6th, the patient entered with a smile. "My pain is gone and my teeth are improving," she said. Examination showed no pus, the gums were firm and pink, but the teeth were still loose. It looked as if something were missing between the teeth and the mucous membrane. By pulling the gums from the teeth, one could look away down to the roots, but the mucous membrane had a healthy appearance. No treatment was given. Patient reported December 30th, and gums looked healthy and the teeth were firm. She remarked that she could crack nuts with these teeth.

---

* Read at the Midwinter Meeting of the Eastern Section of the American Roentgen Ray Society, Atlantic City, N. J., Jan. 25–28, 1923.

Case II. Male, forty-nine years old, policeman. This patient was referred to me because the upper centrals, laterals and cuspids were very loose. The rest of the teeth were replaced by a partial plate. This patient suffered from a marked gingivitis. The gums were not quite as spongy as in the first case, but they bled when touched and showed pus on pressure. Had been under mercurial treatment seven years previous. He received his first *x*-ray treatment on Nov. 10th. After one week's time, improvement of the gums was noticed. On Nov. 15th, the patient stated that the teeth on the left side were somewhat firmer. On December 8th, improvement was marked. The gums looked healthy, but another treatment was given. On December 28th, the patient reported the teeth of the left side were firm, while the right cuspids and lateral incisors had improved, but were still somewhat loose.

Case III. Male, aged forty. Suffering from symptoms of duodenal ulcer. *X*-ray findings proved this diagnosis. Two years previously he had had his appendix removed, and two weeks previously his teeth had been scaled. The examination showed several of the teeth to be loose, and pus could be expressed from the gums. Several painful spots were noticed on pressure over different roots of the teeth. The gums were not as spongy as in the other two cases. Treatment was given. After one week there was a marked improvement, which I attributed to the previous scaling. The painful spots over the roots, which had been proven by *x*-ray examination to be apical pathology, had disappeared. That it was the direct result of the *x*-ray treatment I cannot prove.

My present plans are the following:

1. Take the history of the patient and pay particular attention to the oral conditions.
2. Make a bacteriological examination.
3. *X*-ray examination.
4. Have teeth scaled. Instruct dentist not to use iodine or anything contraindicating *x*-ray treatments. No toothbrush.
5. *X*-ray treatment p. r. n.
6. Weekly inspection.
7. Make bacteriological examination before each treatment.
8. Follow up cases as long as possible to determine whether a permanent cure is established.

The following technique was used with the first patient:

Ma.	Time	Distance	Sp. G.	Filter
6	6	6½ in.	8	Aluminum 2 mm. Wood 1 in. Aluminum 2 mm. Sole leather

but was changed thus:

Ma.	Time	Distance	Sp. G.	Filter
5	4	6½ in.	8	Aluminum 2 mm. Wood 1 in. Sole leather

for the second and third.

FIFTEEN YEARS' EXPERIENCE WITH THE FRACTIONAL DOSE METHOD OF TREATING CUTANEOUS MALIGNANCIES*

BY. J. M. MARTIN, M.D.

DALLAS, TEXAS

MY INTEREST in roentgen therapy dates from 1900. The *x*-rays had even at that early date won a considerable reputation as therapeutic agents in the treatment of skin malignancy. At the third annual meeting of the American Roentgen Ray Society at Chicago in 1902, instructive papers covering the treatment of skin cancer were read by a number of men, prominent among whom was the late Dr. John B. Murphy. These papers were enthusiastically discussed and freely endorsed by members of the society, some of whom are still active. While there was a marked difference of opinion as to the relative value of the static machine and the induction coil as *x*-ray generators, and a great deal was said regarding a correct technique, low and high vacuum tubes, target-skin distance, length of exposure etc., the reported end-results of all of the workers appeared to be excellent. Being new in the field at that time and uninitiated into the mysteries of this therapeutic method, I was forced to the conclusion that skin cancer might be healed with *x*-rays even when the manner of their application varied considerably. The most popular technique at that time required an exposure of ten minutes to the unfiltered rays of a low vacuum tube at a target-skin distance of from 6½ to 8½ in. with a parallel spark-gap of about 3 in. No attempt was made to measure the high-tension current. The exposures were to be repeated every day until redness, heat and itching became noticeable symptoms. At this point it was thought best to stop the treatment for from two to seven days, after which the same method was to be resumed and so continued until the lesion was improved or had disappeared. It was stated that cases were usually kept under treatment for four months or even longer. When we consider that in those days the work was done with the static machine and small induction coils, and that doses were given in inexact terms, we realize that the actual doses administered must have varied widely. This indefinite method of dose administration slowly gave way to the pastilles and photographic strips and finally to the present somewhat imperfect though very satisfactory method of factor determination. No doubt in the not far distant future some more accurate method will be forthcoming; possibly some form of a practical ionization chamber devised to read directly in terms of roentgen-ray intensity.

When the hot wire milliammeter reached a point in its development where it was, in a measure, reliable, we learned that we had been using a high-tension current of approximately 2 ma. in the treatment of epithelioma. Unfiltered doses of 20 ma. min. administered at a target skin distance of 12 in. with a 3 in. parallel spark-gap, would produce a tanning of the skin when repeated three times within a period of ten or twelve days. Six exposures given at two-day intervals would produce a distinct skin reaction, and after ten such exposures a rather active dermatitis was set up which usually healed in four to six weeks.

If we accept the constant $^{45}/_{64}$, advocated by Witherbee and Remer as representing an erythema dose, and substitute our factors in this formula, the dose administered at each seance was approximately one-half an erythema dose. The three exposures would have amounted to one and a half erythema doses and the six exposures would have produced about three erythema doses; while the maximum of ten exposures would have totaled five erythema doses. A day or two elapsed between exposures and in actual practice three such exposures were required to produce an erythema. It seems probable, therefore, that with such a technique six exposures represented two erythema doses and ten exposures represented approximately three erythema doses. With a gas tube and an unreliable milliammeter, constant duplication of dosage was impossible. The dosage may appear at first thought to be unusually heavy, but it must be remembered that three erythema doses given at one sitting will produce a greater degree of reaction in the skin than will the same

---

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24. 1923.

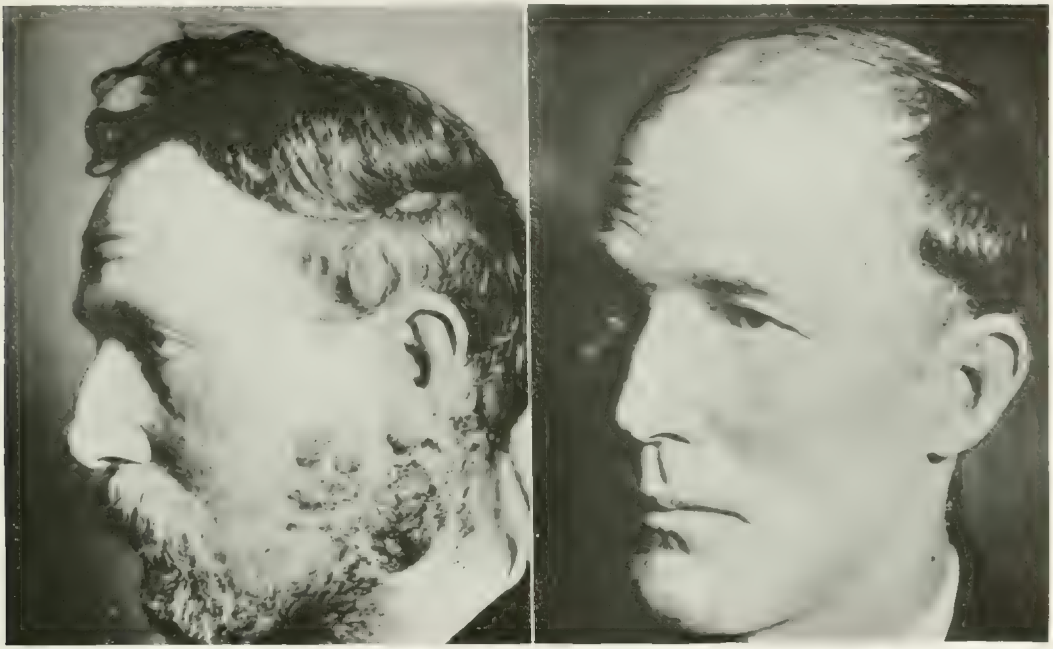


Fig. 1. Epithelioma of the face and neck, declared inoperable. Treated in 1907 with the gas tube, induction coil and the fractional dose method. The lesions healed without complications and the skin is smooth and free from after-effects of the treatment.

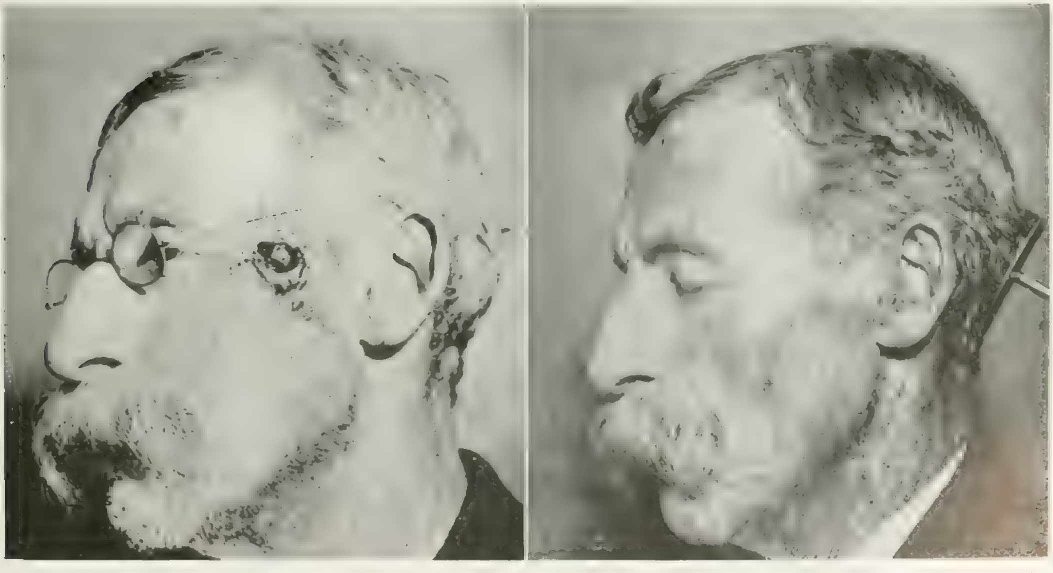


Fig. 2. Epithelioma of the temple region treated in 1907 with the induction coil, gas tube and the fractional dose method. The area treated was perfectly smooth and free from after-effects at the time of death from pneumonia, seven years later.

amount of exposure divided into ten periods spaced over a number of days. It is also my firm conviction that very heavy doses must be applied to skin malignancy if the best results are desired. Serious sequellae have not in my experience occurred in the skin following such doses. Bowen has recently stated that he administers a dose at one seance which constitutes about 7.7 erythema dose, according to the calculations of Witherbee and Remer. He shows photographs of patients whose skin appears to be perfectly healed following this procedure.

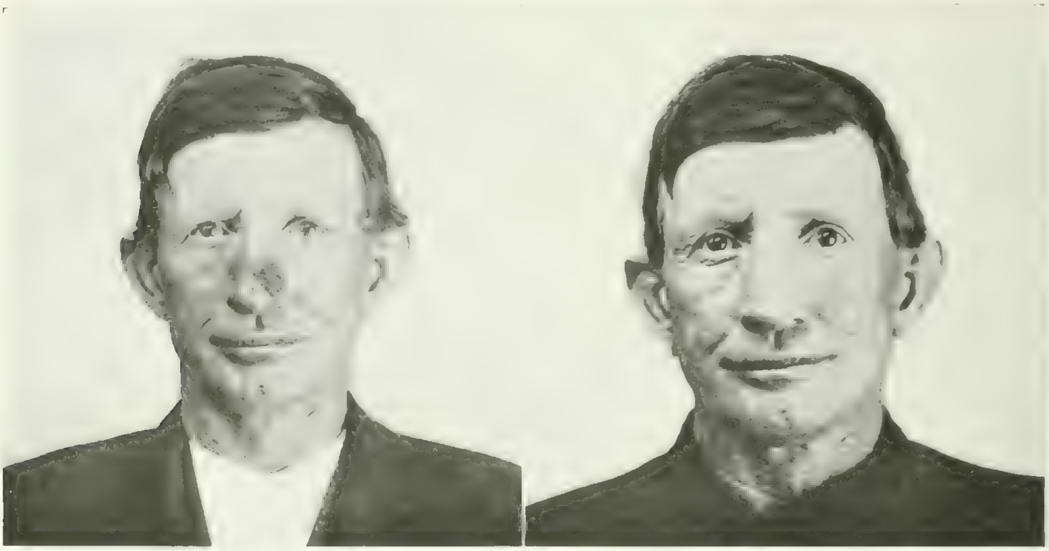


FIG. 3. Removed by means of seven erythema doses of *x*-rays totaling 175 ma. min. There is absolutely no scar or discoloration over the area treated.

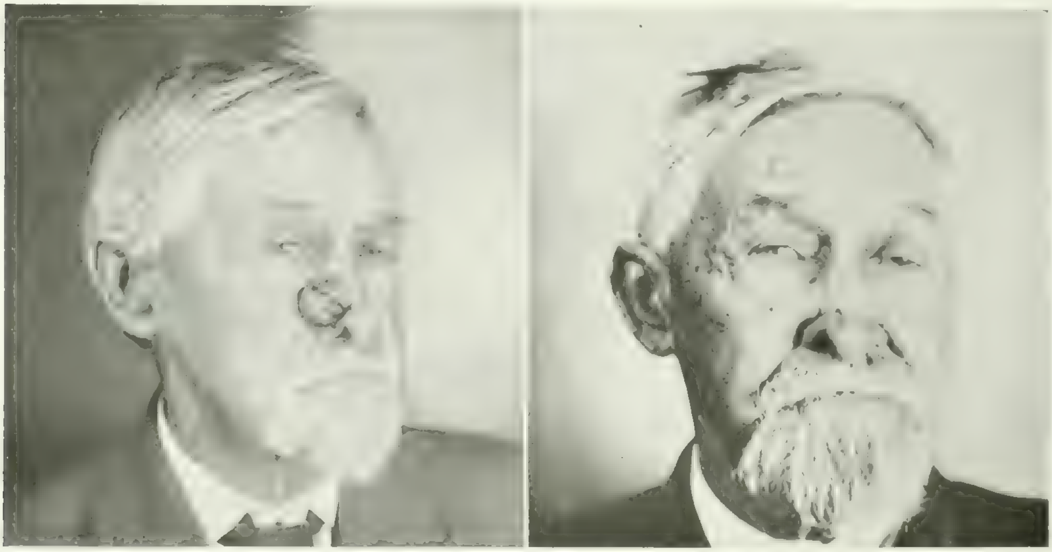


FIG. 4. Epithelioma of the nose completely removed by six *x*-ray exposures totaling 150 ma. min. No deformity exists and a very slight scar remains after more than two years.

In my earlier work I depended more upon the appearance of the skin during the application of the divided doses than upon the factors used. It was my custom to administer a dose every second day until a good reaction appeared. This gave me assurance that the patient had received a total dose amounting to much more than an erythema dose. This method still appears to me to be a valuable one since various lesions in different parts of the body in people of different ages seem to react differently. For instance, a reaction appears earlier on the mucous membrane of the lower lip than over the skin of the back. Some of the reactions obtained had a forbidding appearance for a few weeks, but the end-results were for the most part very satisfactory and justified the resulting crusts and exudates that were produced temporarily.

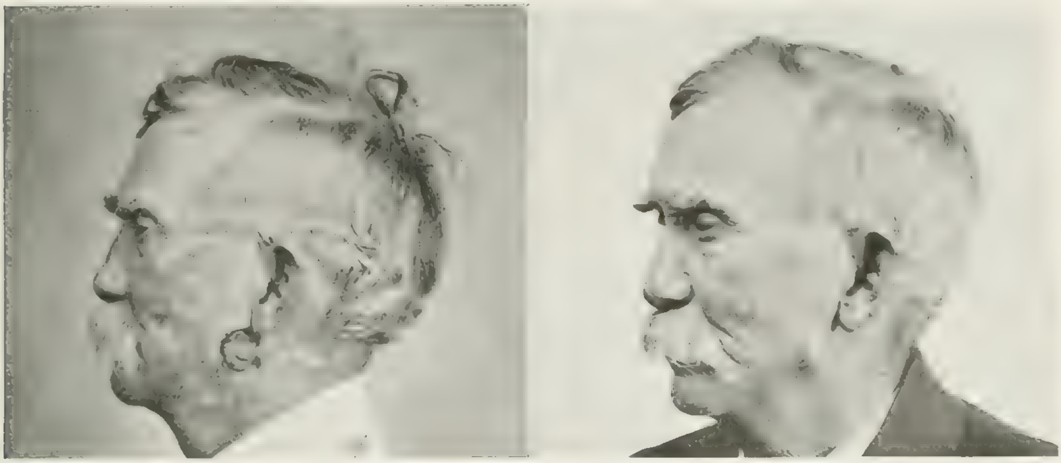


Fig. 5. Epithelioma beneath the ear. After six erythema doses the lesion appeared to heal. Two months later there was evidence of the growth returning. Four additional exposures were given followed by complete disappearance of the lesion.

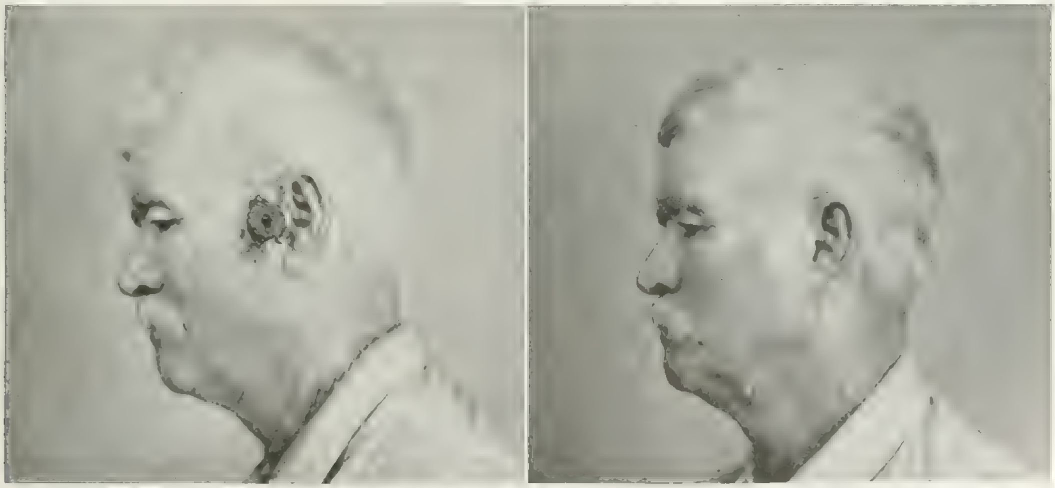


Fig. 6. Epithelioma of the temple region completely removed by means of seven erythema doses of *x*-rays totaling 175 ma. min. The skin over the area treated is slightly lighter in color, but there is absolutely no scar to mark the location of this ugly lesion.

In 1918 the gas tube was finally replaced by a Coolidge tube energized by an interrupterless transformer. A more radical technique was adopted because certain of the more stubborn lesions had not yielded to one series as previously given. The factors for a single exposure consisted of a 10-in. target-skin distance, a 5-in. spark-gap, 5 ma. of current, ½ mm. of aluminum placed just beneath the tube, and an exposure lasting five minutes. The exposures were given every other day and the number ranged from two to ten. According to the formula of Witherbee and Remer for filtered dosage, an erythema dose was administered at each sitting. The smaller lesions received from two to four exposures while the growths of moderate size received six exposures. Only occasionally was it found necessary to use as many as ten exposures. The only factor that was varied with this technique was the number of exposures. The rays were, in each case,

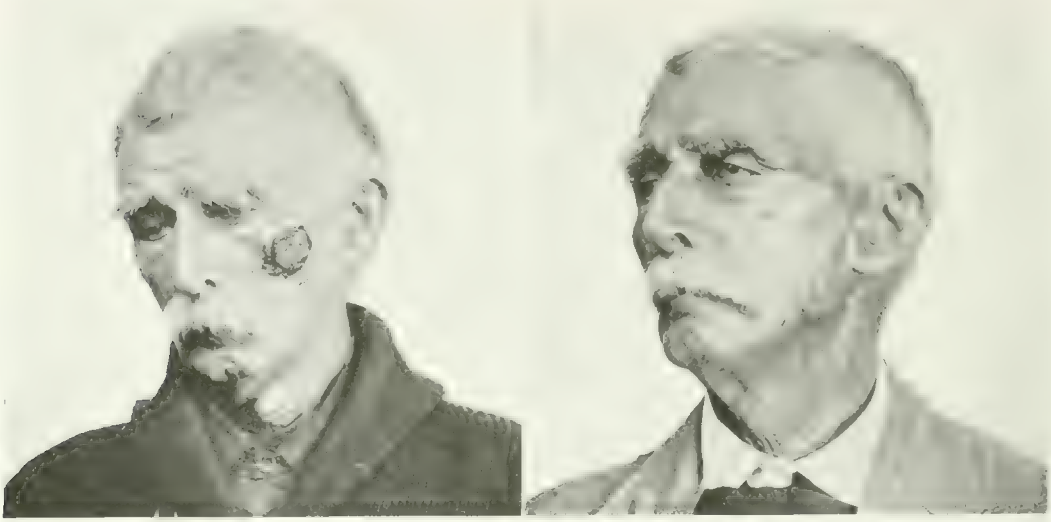


Fig. 7. Epithelioma of the face which required nine erythema doses totaling 225 ma. min. There are no undesirable after-effects.

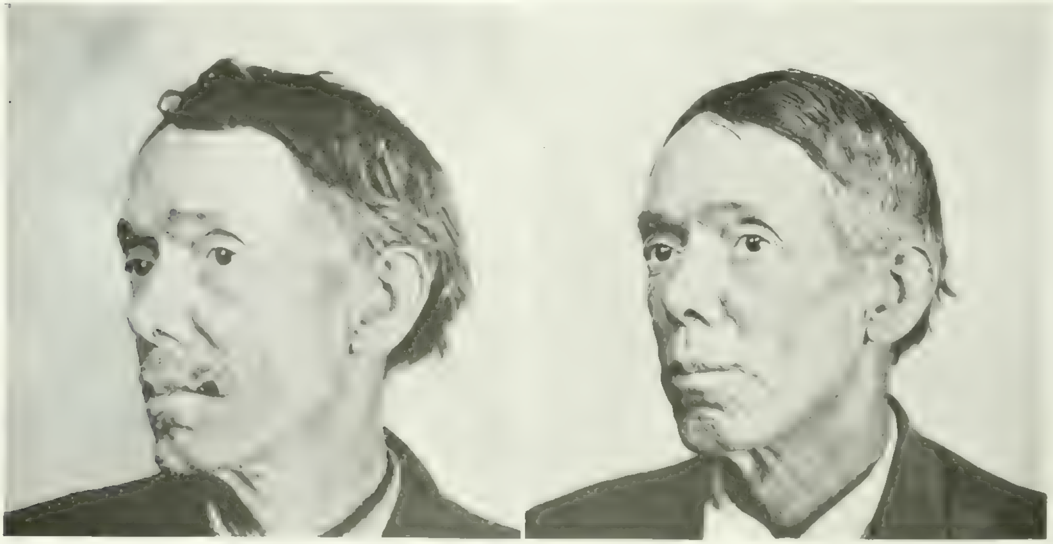


Fig. 8. Epithelioma of the upper lip which responded promptly to six erythema doses of filtered rays, totaling 150 ma. min. The area covered by the lesion is perfectly smooth and the tissues are soft. Two and a half years after treatment there is absolutely no trace of the lesion, the area treated being but a shade whiter than the surrounding skin.

sharply limited, by means of cones and shields, to the lesion and a narrow strip of skin surrounding it. When practical, the skin covering the lymphatic channels draining the area occupied by the lesion was subjected to an erythema dose administered through heavier filters. Fifty ma. min. were given through 4 mm. of aluminum, and four thicknesses of sole-leather with an 8 in. parallel spark-gap and a target-skin distance of 10 in. I have not seen fit to alter this technique and am using it at the present time.

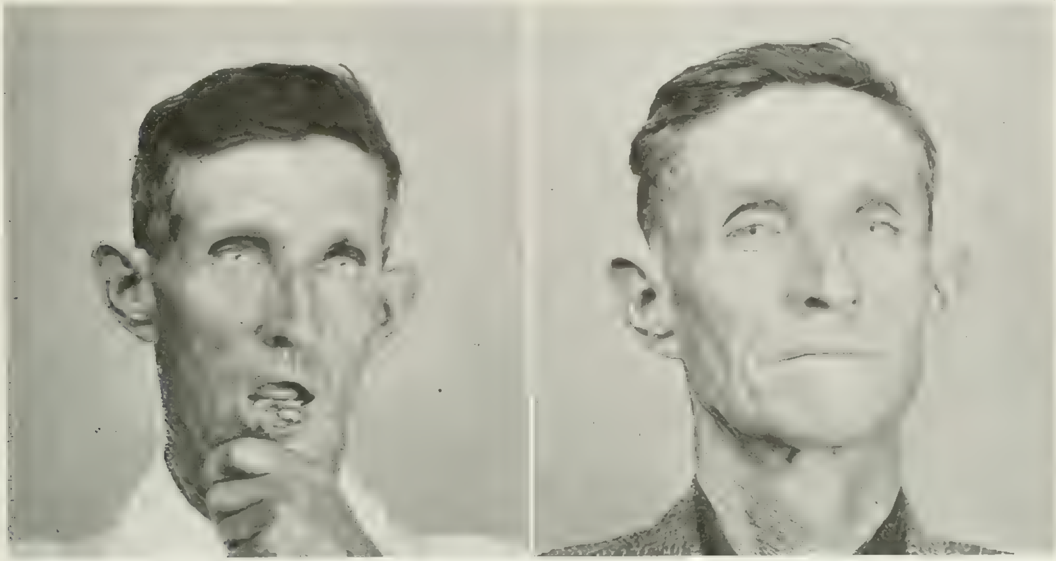


Fig. 9. Epithelioma covering two-thirds of the lower lip. Eleven erythema doses totaling 275 ma. min. given from different positions were distributed over a period of six weeks. Two years after treatment there was no noticeable evidence of the lesion or the after-effects of the treatment.

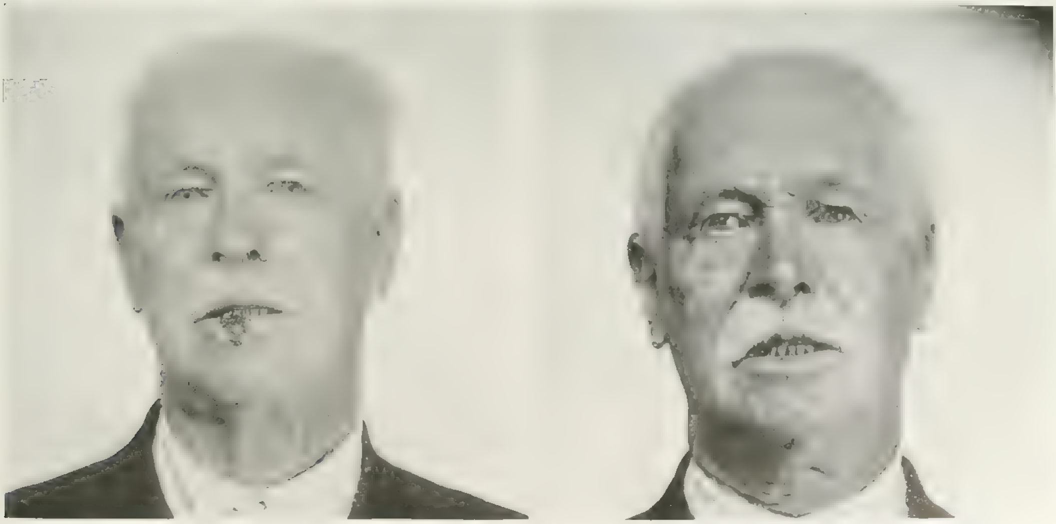


Fig. 10. Deeply ulcerated epithelioma of the lower lip which responded successfully to six erythema doses of *x*-rays totaling 150 ma. min. The treatments were given every second day. There is no scar or other noticeable effect of the disease or after-effect of the method of treatment.

The greater number of my patients come from a distance and as a rule these people are not able to remain under treatment longer than two weeks, neither are they willing to return at monthly intervals, as is too often necessary when the single exposure intensive method is used. This latter has not been productive of good results in my hands. Perhaps the single doses administered were not large enough. Be that as it may, the majority of the cases treated by the multiple-dose method do not as a rule require a second series of treatments. In all but the small lesions a second-degree reaction is produced, no matter how large the growth may be or where it is located. Many will, no doubt, question the advisability of this procedure, but my experience has strengthened my belief that the treatment of cancer must be radical. Continuous attempts at therapy will often do more harm than good. Results are never so good when it is found necessary to ray again a lesion that was insufficiently rayed a month or six weeks previously. The neoplasm should be annihilated once and for all during the first series of treatments. In my experience, atrophy, telangiectasis, keratosis etc., are not disturbing after-results. The skin at the site occupied by the lesion often shows some atrophy and occasionally telangiectases are present in small numbers. However, the skin is smooth and soft and shows none of the deformity that so often follows surgery. The changes that do occur are of such slight importance when compared with the original lesion that their avoidance should not prejudice the roentgenologist in favor of insufficient dosage.

We make it a rule to photograph every case before the treatment is started, and at different times during the period of treatment, should anything of interest appear. The photograph is the best of all records. The negatives are never retouched or changed in any way. When the cases of epithelioma are discharged or sent home, they are given ten postal cards with our address printed on the front, and with the patient's number and a few questions on the back, together with a date in red ink, on which each card is to be filled in and returned. These cards are to be returned every six months. Should a patient fail to send in his cards we write him once a year; usually a little before the Christmas holidays. This generally brings a reply and the desired information. Should a patient be dead, our letter will nearly always get a reply from some member of

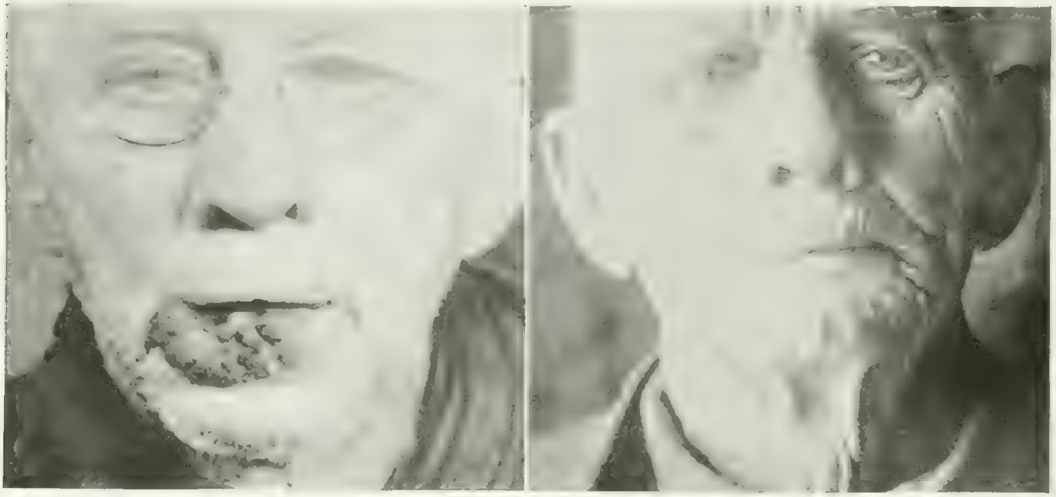


Fig. 11. An extensive epithelioma covering three-fourths of the lower lip and extending well down on the mucous membrane on the inside of the lip. The growth was a stubborn one. The first series of eight erythema doses was not sufficient to destroy the lesion. At the end of two months there was evidence of return. A second series of six erythema doses was given with successful results. There is no deformity in the tissues or unpleasant after-effect after more than three years. There is a slight degree of atrophy and the skin over the area treated is thin, noticeable only to one who understands the cause. Two heavier filtered doses were applied to the areas over the jaw and neck on either side. No other method of treatment was used.

the family. This follow-up system is simple, inexpensive and is meeting with splendid success. In the course of time we hope to have some statistics that will be dependable. We have been following our cases in this manner for only four years. Had we started this follow-up system with photographs and complete records ten years ago, our statistics on *x*-ray therapy for skin malignancy would at present cover over 2,000 cases and would offer strong evidence in favor of the technique described in this paper.

From long experience we are of the opinion that repeated erythema doses of *x*-rays in the treatment of malignant conditions of the skin are productive of better results and more lasting effects than single-dose methods. Our conclusions are based upon an experience of more than fifteen years during which we have treated more than 2,000 cases.

DISCUSSION

Dr. Erskine. In the smokers who had malignancies what percentage of them habitually held the cigar on the other side from which the lesion appeared?

Dr. Lawrence. I am using the single-dose method. My experience also dates back to the time when all of us used fractional doses. Cures were very satisfactory at that time, but now I am using the single-dose method without filtration, giving one full erythema dose. A month later, when the lesion is completely healed, I give one filtered dose a little short of erythema. We can cure these cases by either method, but the single-dose method is timesaving and to me more satisfactory. I use electric coagulation on all cases showing an elevated growth.

Dr. Martin (closing discussion). Answering Dr. Erskine's question, I have no record of a single case of epithelioma of the lower lip where the lesion appeared on the opposite side from that on which the cigar was held. In regard to the smoker with a lesion of the lower lip, it is my experience that the majority of people who have lesions of the lower lip are smokers. Many of the cases shown came into the office with cigars between their lips, and had they not been smoking at the time, I am so sensitive to tobacco smoke, that I could have detected the odor on their clothing or breath. I believe that most roentgenologists of experience agree with me that these people must discontinue smoking if satisfactory results from *x*-ray treatment are to be obtained. After the lesion has been removed a return to smoking increases the danger of a recurrence of the lesion.

Lesions that have not responded after two or more series of *x*-ray exposures appear to have established a sort of immunity to *x*-ray influence, and further treatment should be discontinued. I prefer to receive cases that have not been previously treated by *x*-ray methods.

The erythema dose mentioned in this article is based on the methods of Witherbee and Remer. Personally, I do not believe there is any such a thing as a standard erythema dose. The amount of *x*-rays that will redden the skin of one individual may not make the least noticeable change in the skin of another individual. In heavily-filtered doses of deep therapy a slight tan may be produced after an hour's exposure and the time may be doubled without producing a serious dermatitis. Neither do I believe there is a standard single carcinoma dose. Certain doses recommended may inhibit the carcinoma cells and many of them may be actually destroyed but, in my opinion, some of them often escape actual destruction and may break through the induced fibrosis and set up a recurrence months later.

Through the technique of repeated doses I strive to destroy actually every cell in the lesion by producing an active tissue destruction. The results of such treatment have been shown in the slides and pictures. I would be much gratified if I could get the same universally good results from single exposures.

RADIUM NEEDLES IN MALIGNANT GROWTHS OF THE TONGUE: THE TIME FACTOR

BY A. JAMES LARKIN, M.D.

CHICAGO, ILLINOIS

IN malignancies of the tongue, eight- to ten-hour applications of radium needles give best results. Reports are given herewith of five malignant growths in which the time factor was varied designedly. In all cases, standard twelve and one-half milligram needles were used.

These cases present fairly similar characteristics in that all were men between the ages of fifty and sixty years, all were in good general condition and no lesion was of more than eight months' duration. Microscopic sections revealed squamous-cell sarcoma in 4 and mixed-cell sarcoma in 1, the latter diagnosis seeming to justify the rather destructive dosage employed. The needles were placed 1 cm. apart, since clinical experience seems to indicate it. Approximately 13 per cent of the hard beta rays are available from standard steel needles.

In the cases reported the needles were placed parallel 1 cm. apart at or 1 mm. beyond the periphery of the induration, and homogeneously distributed through the center of the lesion. In each case the lymphatics draining the area were irradiated to the skin tolerance dosage with gamma ray.

Brief case records are as follows:

CASE I. Male, aged fifty-five. Good physical condition.

Lesion. Present six months; size and shape of an almond; raised, ulcerated, cauliflower, bleeding, indurated and painful. Located in the central portion of the margin and ventral surface of the right side of the tongue. No palpable lymph-nodes. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Nov. 17, 1921. Four 50 mg. needles inserted about the periphery for six hours—300 mg. hrs. Lymphatic area irradiated with gamma ray.

Course. June 1, 1922. Lesion did not entirely disappear. Apr. 3, 1923. Patient alive, has extensive recurrences involving the site and the floor of the mouth.

CASE II. Male, aged fifty. Good general condition.

Lesion. Present 8 months; 3 × 2.5 cm. on left margin and ventral surface of middle portion of the tongue, indurated, ulcerated, friable, bleeding, with but little pain. No palpable lymph-nodes. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Sept. 5, 1922. Eight 100 mg. needles inserted parallel, 1 cm. apart in and at the periphery of the induration for eight hours—800 mg. hrs. Lymphatic area irradiated to skin tolerance dosage with gamma ray.

Course. Jan. 15, 1923. Lesion healed. Smooth small white scar, no glands. Gain of 10 lbs. Apr. 3, 1923. Lesion healed, no palpable lymph-nodes, no pain.

CASE III. Male, aged fifty-seven.

Lesion. Present six months. Ulcer 1.5 × 1 cm. left dorsum of tongue, punched-out border. Induration for 1.5 cm. beyond ulcer margin. Several palpable lymph-nodes on both sides of the neck from .5 to 3 cm. in diameter. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Feb. 20, 1923. Eight 100 mg. needles inserted 1 cm. apart in and around the periphery of the lesion for ten hours—1,000 mg. hrs. Lymphatic area heavily irradiated with gamma ray.

Course. Mar. 26, 1923. Lesion healed, no induration, firm rubbery condition with depression at site of ulcer. Apr. 3, 1923. Lesion healed, small depressed white scar, lymph-nodes same as before treatment.

CASE IV. Male, aged fifty-five. Fair general condition. Lost some weight.

Lesion. Present four months. Left half of tongue from base to within 1 cm. of tip, involved in induration ulcer 3 × 2 × 1 cm. No palpable lymph-nodes. Patient complains of headaches. Microscopic diagnosis, squamous-cell carcinoma.

Treatment. Oct. 14, 1922. Eight 100 mg. needles inserted parallel 1 cm. apart into one-half of the lesion, for twelve hours—2,400 mg. hrs.—repeated two days later in the other half.

Lymphatic area irradiated to skin tolerance dosage with gamma ray.

Course. Oozing hemorrhage with large

slough involving whole ulcerated area. Crater 3.5 × 3 × 1.5 cm. present. Dec. 22, 1922. Ulcerated crater still present; patient in coma for three days. Died of metastasis to the brain.

Case V. Male, aged fifty-six. Fair general condition. Lost some weight.

Lesion. Present three months; size of small hen's egg, smooth, hard, ulcerated superficially, with broad pedicle, non-indurated base. Located on anterior portion right margin and ventral surface of the tongue. No involvement of lymph-nodes. Microscopic diagnosis, mixed-cell sarcoma.

Treatment. Jan. 17, 1923. Eight 100 mg. needles inserted into pedicle close to base for eighteen hours—1,800 mg. hrs.

Course. Feb. 17, 1923. Lesion completely sloughed off, leaving broad sloughing area 3.5 × 3 × 1 cm. encroaching markedly into normal tissue. Reaction severe. Patient weak. Lost 20 lbs. Apr. 3, 1923, ulceration 1 × 1.5 cm. healing. Crater in the tongue. Patient much improved. No involvement of lymph-nodes.

CONCLUSIONS

1. Standard needles containing 12.5 mg. radium element placed 1 cm. apart and parallel in malignant growths of the tongue yield the best clinical results if left in place eight to ten hours.

2. Six-hour application permits of recurrence *in situ*.

3. Twelve and eighteen-hour applications produce excessive sloughing with tendency to hemorrhage and such severe reactions that the patient's local and general resistance are seriously lowered.

THE RADIUM EMANATION SLIDE RULE FOR USE IN THE FIELD OF THERAPEUTICS

BY JOHN RANSOM, B.S.

Frank Edward Simpson Radium Institute

CHICAGO, ILLINOIS

The convenience and usefulness of the ordinary types of slide rule are well known and appreciated by those accustomed to its use. Divided with special scales for the solution of particular problems in certain fields, the slide rule has many times in the past been applied to very great advantage, and we are hopeful therefore that it may serve in the field of therapeutics as well.

Taking the Mannheim type of slide rule, we have substituted for the trigonometric and logarithmic scales on the back of the slide, two special scales, one (marked F, Figure 1) for computing the decay of radium emanation and the other (marked E) for computing millicurie-hours by finding the integral of the strength of the radium emanation into the time, or

$$\int_0^t A_0 e^{-\lambda t} dt = A_0 \left(\frac{1 - e^{-\lambda t}}{\lambda} \right)$$

The logarithmic scale, or what is often called the scale of equal parts, has been divided upon the front side of the slide between the B and C scales, thus permitting all the operations possible with the regular Mannheim rule, except those of finding sines and tangents.

To use the special scales the slide is reversed, thus bringing the emanation decay scale, F, over the logarithmically divided scale lettered D; and scale E, which we might call the dosage scale, under the logarithmic double scale A.

The decay scale, F, figured in days, is one of equal parts due to the fact that the emanation decay is exponential. This is clearly seen to be the case when it is remembered that the slide rule geometrically adds logarithms and that log $e^{-\lambda t}$ is proportional to the time t.

To use the decay scale, F, either the right or left end mark, the proper one being found by trial, is brought over the strength of the emanation on the contiguous scale D; and under the time in days and hours on scale F, is read on scale D, the strength which the emanation will have that many days and hours later. As with any slide rule, the values on the D scale can be considered as multiplied by any multiple or sub-multiple of 10, and in the computation the decimal point placed by inspection. There is little likelihood of confusion in this if it be remembered that the emanation decays to 1/10 value in about thirteen days.

When it is desired to find the strength of the emanation more than twelve days later, the slide must be shifted twice. Thus for example, if the initial value of the emanation is 83 mc. and we wish to learn what strength it will have on the seventeenth day, we place the right end division or right index of scale F over 83 on scale D, and under 7 on scale F, we read 23.5+ on scale D. The cross-hair of the glass runner is then placed over this point on scale D and the slide is shifted to bring the left end mark under the cross-hair. Then under 10 on scale F, we read on scale D the figure 3.88+, which is the value of the emanation at the end of seventeen days.

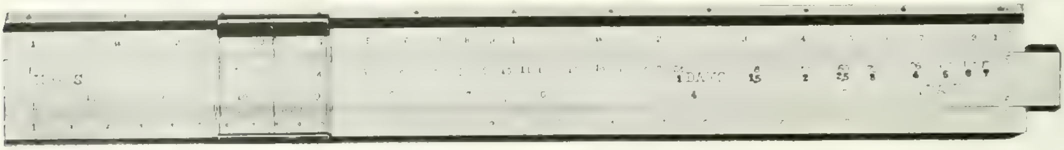


FIG. 1. The slide rule divided with special scales for computing decay of radium emanation and dosage.

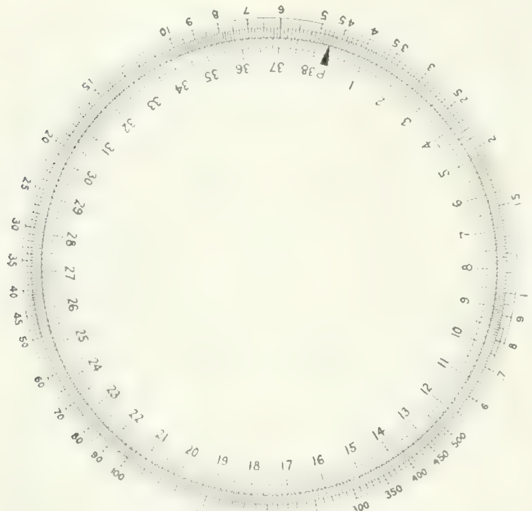


FIG. 2. The circular slide rule for computing decay of radium emanation.

To use the dosage scale E, or better, the scale for computing millicurie-hours, the proper division of the E scale is placed under the initial strength of the emanation on scale A, and over the number of hours for the application on scale E is read on scale A the number of millicurie-hours, a factor in the dosage.

The decimal point in this computation is placed either by inspection or according to some very simple rules.

Another form of rule, and one which we have found much easier to use when only the decay of radium emanation is to be computed, is circular in form. It consists of two concentric rings held together by a tongue and groove, thus allowing one ring to slide within the other.

The outer ring is divided with a logarithmic scale corresponding to scale D of the straight rule but repeated three times and figured from 500 down to 0.5 mc. The inner ring is divided with a scale of equal parts corresponding to scale F of the straight rule but figured in days up to thirty-eight days.

Since in practice it is seldom necessary to compute quantities of emanation greater than 500 or less than 0.5 mc., the circular rule in most cases can be used without the necessity of keeping in mind where the decimal point should be placed.

To use this rule, the wedge division on the inner scale is placed over the initial value of the emanation on the outer scale. Under 1 can be read the value of emanation one day later; under 2, the value two days later, and so on up to thirty-eight days. It is unnecessary to shift the relative position of the rings for any time less than thirty-eight days. The inner ring is divided into parts, each equivalent to four hours, but for accurate work, fractional parts of these may easily be estimated.

In contructing the different scales described above, the decay constant λ has been assumed to be equal to .00751.

FLAT DIAPHRAGM OF SPIRAL DESIGN IN ROENTGENOGRAPHY

BY HAROLD S. SAWFORD

Department of Roentgenology, Sophian Clinic

KANSAS CITY, MISSOURI

APPARENTLY the only design that is practical for a flat grid or diaphragm in roentgenography is the spiral. This design is not only practical, but has many features that are well worthy of consideration. Firstly, it reduces to a minimum the unavoidable space between patient and film. Secondly, it obliterates completely the grid shadows irrespective of the length of exposure. Moreover, it is very efficient in the filtering out of scattered rays, although no attempt is made to give figures in this respect.

In construction of the disk proper, cork was used as a spacer. The filtering element (lead strips) were 0.5 in. deep, and spaced 0.125 in. apart, making a ratio of one (1) to width, and four (4) to depth. Beginning close to a center, the strips being spaced evenly, they radiate outward to the periphery in spiral form. In radiating outward they gradually form an angle which becomes more and more obtuse. This slanting of lead strips is governed by the distance of tube target to film (26 in.), and allows the primary or image-forming rays to pass without impinging on the sides.

The disk revolves in a suitable circular track of slightly greater diameter. The energy is supplied by a small, high-speed, universal motor, using a small pulley and an endless belt. A circular sheet of aluminum is stretched over as a support for the patient, allowing 0.5 in. for sagging. This makes a space of approximately 1 in. from cover surface to film at any point.

Owing to problems in construction it was found advantageous to use a plurality of spirals. It is not possible, in using four or more strips, to space them evenly in the center. Adjustment can be made, however, that will show a roentgenograph free from lines. Any inaccuracy in adjustment of the center will result in more or less faint circles. These faint lines may be very conspicuous superimposed on, say, a kidney shadow, but may be entirely lost in the varying density of a vertebra.

It becomes apparent that a relatively slow but very even movement is obtained, as the spirals radiate to or from the center. There is a considerable latitude in the choice of speed, but two or three revolutions of the disk per second give freedom from grid shadows for extremely short exposures. As the movement is continuous, no variation in speed is necessary.

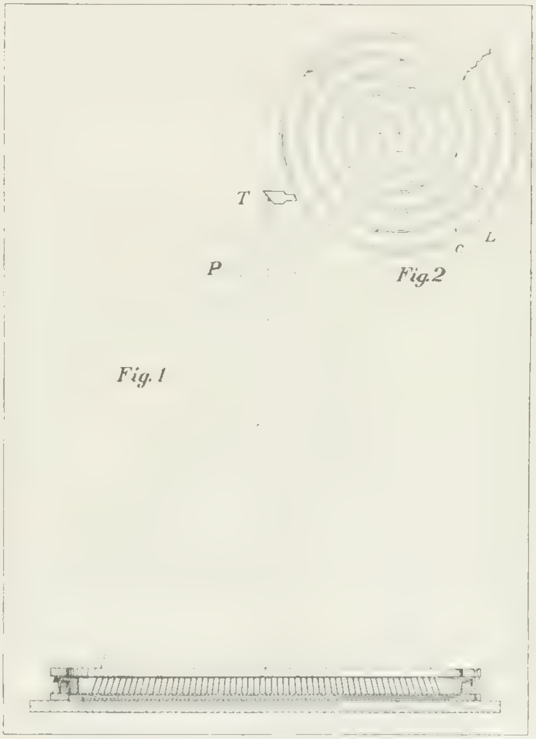


FIG. 1. Diagrammatic section of disk showing slanting strips and their relation to path of primary rays (*P*) from the target (*T*).

FIG. 2. Diagram showing plan of central portion of disk, using two strips. (*C*) Cork spacer. (*L*) Lead strips (enlarged).

It seems interesting to observe the relation of scattered radiation to the spiral. The greater the deviation of scattered rays from the primary path, the more efficient this design seems to be. Apparently 100 per cent efficiency is reached for these most aberrant rays, governed of course by the spacing and depth of strips.

With a ratio of one (1) to width, and four (4) to depth and with penetration equal to a six-inch back-up spark, an excellent clean-up is obtained on average thickness. If higher penetration is used, there seems to be some improvement if cones are used to limit the area rayed.

The suppression of scattered radiation by the use of grids or diaphragms apparently increases greatly the length of exposure. The shadows of the lead strips cover a relatively small area of the film. Theoretically this indicates rather, that a normal or correct exposure is permitted by filtering out the scattered rays. In view of the results obtained, it is reasonable to assume that the spiral type of disk can easily be reduced in depth to 0.25 in. or less. It is obvious that the increase in definition will compensate for efforts along this line.

Many thanks are due to Dr. A. Sophian and Dr. A. C. Clasen for their kindly criticism and encouragement.

BIOLOGICAL REACTIONS OF X-RAYS: EFFECT OF RADIATION ON THE NITROGEN AND SALT METABOLISM

BY CARL F. CORI, M. D., AND G. W. PUCHER

With the assistance of Miss H. Goltz

From the State Institute for the Study of Malignant Disease, and the Chemical Department of the Laboratories of the Buffalo General Hospital

BUFFALO, NEW YORK

NUMEROUS studies of the effects of radium and *x*-rays on the metabolism of man and animals have been carried out. However, the experiments recorded in the literature are so scattered and the conditions outlined by the different investigators so variable that it is almost impossible to correlate the data in such a way as to secure reliable composite results. Since the advent of the so-called "blood chemistry" a large amount of data, very inconclusive indeed, on the effect of radiation on the composition of the blood have been reported. These variations, in the main, are probably due, as shown by our experiments, to the different periods of blood withdrawal after radiation. Since the blood equilibrium adjusts itself very quickly, marked changes in the blood will only be noted either during the radiation period or at very short time intervals thereafter. Furthermore, since the introduction of "deep ray" therapy for the treatment of malignant disease no extensive metabolism studies are available which would be of value in interpreting the effects of this type of treatment.

In general, previous investigations have shown that there is an increase of the total nitrogen output in the urine after treatment with radium or *x*-rays. Of the various nitrogenous compounds which might be expected to have been increased after such a treatment, the uric acid is the only one about which there are any consistent data. This compound is found to be increased most markedly in the postradiation periods of leukemia patients. This increase of uric acid is interpreted as being due to the decomposition of the nucleoproteins. This view seems to be substantiated by the observations that the total phosphorous elimination is also increased under similar conditions.

In undertaking this work it was thought that perhaps by a very careful control of conditions and simultaneous analysis of the organic and inorganic metabolites, the metabolic changes as evinced by urinary excretion might be more marked and give some clue as to the mechanisms of tumor destruction. However the net results of these experiments outside of the new and strange behavior of the chloride metabolism were somewhat disappointing. Nevertheless, the data seemed worth while reporting since they present a rather complete organic and inorganic metabolic study of the two types of *x*-ray therapy under comparable conditions.

EXPERIMENTS

Three cases, a carcinoma of the uterus, a lymphosarcoma and a lymphatic leukemia were studied. Before commencing the experimental period, these patients were placed on their special diets for four to five days and maintained on these for the duration of the experiments. Great care was taken to obtain an accurate record of the amount of food ingested. The urine was collected for twenty-four-hour periods and special precautions taken to obtain complete samples. Any doubtful samples were rejected. The urine was preserved with toluene and kept in the ice box.

For the substances determined we employed the following methods:

1. Total Nitrogen. A macro Kjeldahl method using 1 to 5 c.c. of urine was employed. The digestion mixture was that recommended by Folin and Wright.[1]

2. Urea. This was estimated by the urease method of Van Slyke and Cullen.[2]

3. Creatinine and Creatine. Folin's method[3] was used.

4. Uric Acid. This was usually determined by two independent methods, that of Folin[4] with the precautions outlined by Pucher[5] and the direct method of Benedict and Franke.[6] The latter method gave good results on normal urines but considerably too high values as compared with the Folin method in the postradiation periods.

5. Amino Acids. The method recently developed by Folin[7] was utilized.

6. Ammonia. This was evaluated by the microchemical method of Folin and MacCallum[8] substituting titration for nesslerization.

7. Chlorides. Whitehorn's[9] and Volhard's methods were used.

8. Sulphates (Inorganic and Total). The total sulphates were determined by the Benedict[10] method. The inorganic sulphates were also determined gravimetrically as barium sulphate.

9. Phosphates. Organic and inorganic phosphates were estimated by the colorimetric method of Bell and Doisey.[11]

10. Acidity. This was estimated by titration with n/10 alkali.

11. Carbon Dioxide. The urine was equilibrated at alveolar air tension and the carbon dioxide estimated in the Van Slyke apparatus.

The reliability of each method was determined by each of us analyzing the same samples independently with different sets of reagents and apparatus. No method was utilized until our independent results could be duplicated within at least 5 per cent.

Case I. Male, aged fifty-five years. Lymphosarcoma.

Treatment: "Deep ray" therapy.

Past History. Illness began March, 1922, with involvement of the glands under the arms and of the neck. In April the inguinal region was also enlarged. No treatment was received by the patient before coming under our observation.

Present History. In September a lymph-node was removed from the axilla and diagnosed as lymphosarcoma. At that time the patient had large nodes on both sides of the neck in the axillae and in the inguinal region. These nodes increased in size very rapidly. His blood count, except for a slight lymphocytosis, was normal. On November 15th, about two months after his *x*-ray treatment, the patient was reexamined and his nodes had almost disappeared except in the right and left groin, where they were still slightly enlarged.

Experimental Period. The patient was placed on a purine-free diet on the 12th of September. The diet consisted of 2,800 calories with 80 gm. of protein, the calculations being made from a diet chart. This diet was always completely consumed except on the two days of *x*-ray treatment. On the 26th of September the breakfast only was consumed. It consisted of 836 calories with 16 gm. of protein. On the 27th of September part of the breakfast was refused, leaving for the whole day 2,275 calories with 79 gm. of protein. Since previous experiments have shown that patients generally refused to eat their whole diet one to two days after the *x*-ray treatment, no attempt was made to determine an exact nitrogen balance, as in food value experiments. The same difficulty was encountered in animal experimentation.

Discussion of Data. It will be observed that already within twenty-four hours after the treatment there is a slight increase of the total nitrogen excreted. This value, of course, is low since only part of the diet was consumed, but nevertheless distinctly higher than the average value (10.4 gm.) of the total nitrogen excretion during the normal period. In the following two days, during which the whole diet was consumed, the total nitrogen excreted increased 35 and 44 per cent respectively. On the fourth day after the radiation, the normal nitrogen output was again reached and remained constant until the 6th of November when the observations were discontinued. It will be noted that this increase in total nitrogen is due chiefly to a parallel increase in the amounts of urea and ammonia excreted. No appreciable change in the creatinine or creatine metabolism could be detected. The uric acid nitrogen, which, due to the purine free diet, was of endogenous origin, showed in the normal period an average of 0.074 gm. N per twenty-four hours. This value was increased one day later than the total nitrogen and also returned to normal one day later. The average increase of uric acid nitrogen was 100 per cent over that in the normal period.

Since we obtained an increase of endogenous uric acid which undoubtedly is due to the destruction of nuclear material, one should also expect an increased excretion of

TABLE I

RADIATION SHEET

CASE I. SEPT. 18–OCT. 7

Date	Time, Min.	Area Radiated	Size Skin Area	Filter Copper	Sp. Gp.	Ma.	Focal Skin Dist.	Skin Dose	Per Cent Depth Dose	
9–26	36	L. neck	15×15	5	200	6	50	70	36	"Deep Ray" Therapy
	36	R. neck	10×15	5	200	6	50	70	36	
	36	L. neck	10×15	5	200	6	50	70	36	
9–27	36	R. neck	15×15	5	200	6	50	70	36	
	36	L. groin	10×15	5	200	6	50	70	36	
	36	R. groin	10×15	5	200	6	50	70	36	

	Vol., C.c.	Sp. Gr.	Total N	Urea + N.H.$_3$N., G.	Amino Acid, N	Uric Acid, N	Creatinine, N	Creatine, N	Chlorides, Gm.	Inorganic Phos., Gm.	Organic Phos., Gm.	Total P. Cal.	Weight, Kg.	Remarks
18–19	660	1.027	10.4	9.1	....	....	.....	....	....	.....	.....	...	75.3	2800 cal.—80 gm. protein‡
19–20	930	1.025	11.1* 11.2	10.6		0.074	0.478	0.00	6.15	0.425	0.008	0.433	75.0	2800 cal.—80 gm. protein
20–21	1225	1.021	9.06* 9.13	2.56	...	0.06	0.375	0.065	8.15	0.328	0.0098	0.338	73.0	2800 cal.—80 gm. protein
21–22	1690	1.017	10.64* 11.14	9.88	0.157	0.076	0.464	0.066	11.05	0.595	0.011	0.606	....	2800 cal.—80 gm. protein
22–23	1955	1.011	9.4* 9.87	8.68	0.120	0.073	0.427	0.100	6.80	0.612	0.026	0.638	....	2800 cal.—80 gm. protein
23–24	1350	1.019	10.31* 10.64	9.67	0.136	?0.033	0.417	0.061	7.20	0.842	0.025	0.867	73.7	Basal metabolism = +18.9%
24–25	1550	1.017	9.88* 10.89	9.06	0.257	0.086	0.396	0.079	8.30	0.693	0.03	0.723		
25–26	1100	1.022	9.62	.....	...	0.078	0.414	0.074	6.60	0.664	0.04	0.704	73.1	Basal metabolism = +21.4%
26–27	1415	1.021	10.08* 11.41	9.50		0.049	0.405	0.099	5.09	0.999	0.023	1.022	...	Treatment† 836 cal.—16 gm. protein
27–28	1645	1.017	12.8* 14.03	12.2		0.148	0.42	0.110	4.25	2.1	0.104	2.204	...	2275 cal.—79 gm. protein
28–29	1832	1.016	14.27* 14.97	13.6		0.145	0.438	0.085	2.06	1.37	0.108	1.478		Node diminishing rapidly in size. 2800 cal.—80 gm. protein
29–30	1385	1.017	9.25* 9.43	8.60		0.155	0.35	0.05	4.95	0.755	0.025	0.755		2800 cal.—80 gm. protein
30–1	1285	1.020	9.45* 9.21	8.98		0.072	0.40	0.00	6.59	0.675	0.025	0.700		2800 cal.—80 gm. protein
1–2	1055	1.024	8.72* 9.57	8.28		0.068	0.367	0.011	6.10	0.700	0.012	0.712		2800 cal.—80 gm. protein
2–3	Lost													
3–4	980	1.020	8.95	7.97					.....				72.7	Basal metabolism = +19.6%
4–5	1084	1.019	9.9	9.12				.	4.55	....	....	...		
5–6	1390	1.018	10.9	9.72				.	5.66	....	....	...		

* = Total nitrogen calc. from fractions determined.
† = See radiation sheet.
‡ = Patient on purine-free diet (see Experiments).

the total phosphorus. This is confirmed by our experimental data, but it is interesting to observe that the phosphorus increase more closely parallels the increase of total nitrogen than that of the uric acid. This indicates that there is a retardation in either the formation or excretion of the uric acid. This increase of phosphorus confirms the data of other investigators.

As far as we were able to determine, no changes of the chloride metabolism under the influence of *x*-rays are reported in the literature. It will, however, be noted in this case, and especially in Case III, that there is a very pronounced decrease in the amount of chlorine excreted after the radiation period. This decrease is not due to changes in the salt content of the diet nor to a water retention, since no edema or change in body weight or decrease in urinary volume was observed after the *x*-ray treatment. The patient suffered no rise in temperature after the treatment. His average excretion of chlorine was 7.7 gm. during the normal period, while three days after radiation it had decreased to 2.06 gm.—a change of 72 per cent.

Case II. Male, aged fifty-eight years. Lymphatic leukemia.

Treatment: Light radiation.

Past History. The patient first noticed the enlargement of his glands about eight months ago. Since that time the enlargement has been progressive and he has lost about 60 lbs. in weight.

Present History. He was admitted to the hospital on August 4, 1922, and showed a general enlargement of the lymph-nodes up to the size of a large orange. The spleen was markedly enlarged, the lower pole being about 4 in. below the costal margin. On August 8th a node was removed from the axilla and diagnosed as lymphatic leukemia. Bleeding from the operation scar continued for several days. When admitted, the patient had a slight anemia (65 per cent hemoglobin) and 250,000 leukocytes, chiefly small lymphocytes. His blood platelets were extremely low. The patient received three *x*-ray treatments over the spleen and showed marked improvement both as regards decrease in the number of leukocytes and size of the nodes of the neck and axillae.[10]

Experimental Period. On August 9th the patient was placed on a purine-free diet consisting of about 2,400 calories with 80-90 gm. protein. The protein values recorded in Table II are based on the actual amount of food consumed. The collection of our experimental data began on August 14th.

Discussion of Data. The table indicates a normal and three postradiation periods. The amount of radiation, as indicated by the data, was the same in all three periods, but the patient showed a marked reaction only after the third treatment. It was during this period that similar effects on the metabolism as recorded in Table I were observed. It will be noted that in this, as well as in the preceding case, the value for the total nitrogen as determined and as calculated from the partial nitrogen fractions checked within a few tenths of a gram. However, during the increase of the nitrogen after the *x*-ray treatment the difference between those two values was as high as two grams. This large difference disappeared as soon as the nitrogen excreted became again normal. The nature of this undetermined nitrogen has not yet been established. It will also be observed from the table that the increased elimination of uric acid following the radiation is accompanied by a tremendous increase (9.1 mg. per 100 c.c.) of the blood uric acid.

The decrease in the excretion of the chlorides was much more pronounced than in Case I. The decrease persisted for six days, reaching a minimum of 0.74 gm. of chlorine in twenty-four hours. After this day the patient was placed on a high salt diet, but nevertheless even after forty-eight hours the retention of chlorides still persisted.

Case III. Female, aged thirty-eight years. Carcinoma of the cervix uteri.

Treatment: "Deep ray" therapy.

Past History. Illness began in January, 1921 with bleeding from the uterus.

Present History. Gynecological examination on July 17th showed a large ulcerating tumor of the cervix with infiltration of the parametria. Microscopic diagnosis of excised tissue indicated carcinoma.

CASE II.—AUG. 14 SEPT. 16.

TABLE II

RADIATION SHEET

Date	Time, Min.	Area Radiated	Filter, Al.	Voltage, Kv.	Ma.	Distance, In.	
8/18/22	7	Spleen anterior	7 mm.	85	5	10	Light Radiation
8/26/22	7	Spleen posterior	7 mm.	85	5	10	
8/9/22	7	Spleen posterior	7 mm.	85	5	10	

Date	Volume	Sp. Gr.	Acidity	Total N	Urea N	Ammonia N	Amino Acid N	Uric Acid N	Creatinine N	Creatine N	Chlorides as Cl	Inorganic P	Weight Basal, kg.	Metabolism, Per Cent	Blood Urea	Chemistry Uric Acid	Leukocytes	Remarks
13-14	760	1.026	134	12.65* 12.23	11.03	0.894	0.163	0.133	0.464	0.00	3.57	0.352	76.0	+47.1	27.9	..	224,000	1635 cal.—63 g. protein‡
14-15	700	1.030	395	12.1* 11.59	10.35	0.902	0.171	0.173	0.514	0.00	4.26	0.528			27.9	3.8		2552 cal.—100 g. protein
15-16	680	1.026		10.07* 11.70	8.24	0.905	0.215	0.227	0.448	0.033	3.60	0.401		..			245,000	2577 cal.—102 g. protein
16-17	700	1.028	336	10.48* 11.24	8.58	0.901	0.239	0.187	0.440	0.048	3.72	0.326	...					2600 cal.—94 g. protein
17-18	[illegible]	1.026	332	10.13* 10.01	8.20	0.954	0.177	0.187	0.459	0.074	4.59	0.445	78.4	+55.1				2370 cal.—92 g. protein
18-19	680	1.030	354	9.36* 9.85	7.35	1.115	0.259	0.153	0.425	0.056	3.84	0.400		......	....	...	220,000	Treatment† 2454 cal.—85 g. protein
19-20	870	1.027	348	9.68* 10.20	7.72	1.117	0.172	0.180	0.396	0.081	3.87	0.735			....	...	....	2576 cal.—98 g. protein
20-21	800	1.022	302	9.33* 10.44	7.81	0.761	0.194	0.160	0.337	0.070	4.29	0.910	77.4	+47.5	24.5	3.6	....	2261 cal.—90 g. protein
22-23	740	1.020	455	8.96* 9.77	7.01	0.950	0.221	?0.317	0.309	0.060	3.06	1.04	....	......	....	...	......	2320 cal.—80 g. protein
23-24	565	1.020	352	7.16* 7.54	5.68	0.766	0.210	0.150	0.363	0.00	2.66	...	...	.	....	...	......	2460 cal.—88 g. protein
24-25	1058	1.024	400	14.22* 14.25	11.70	1.5004	0.318	0.100	0.522	0.089	5.70	1.08		...	....	...	......	2463 cal.—102 g. protein
25-26				9.45*												Treatment†		2316 cal.—88 g. protein
26-27	930	1.022	415	9.74	7.48	1.061	0.143	0.230	0.473	0.067	4.08	0.625	76.4	+47.1	...	...	80,000	2473 cal.—90 g. protein
28-29	1220	1.012	410	9.22* 9.65	7.47	1.166	.	0.13	0.371	0.078	3.75	0.700	..	......	..	..	61,000	2443 cal.—95 g. protein
29-30	1505	1.008	241	11.03* 11.16	8.59	1.505	0.160	0.23	0.448	0.100	5.28	0.078	...	....	....	...	.....	2649 cal.—100 g. protein
30-31	1443	1.016	140	10.02* 9.93*	7.67	1.58	....	0.28	0.418	0.078	6.00	0.025	....	....	....	...	......	2340 cal.—90 g. protein
31-1	1125	1.008	495	10.30* 10.47	7.86	1.60	0.185	0.13	0.415	0.103	5.93	1.02	....	.	....	...	......	2490 cal.—86 g. protein
1-2	925	1.012	102	6.74* 7.02	4.78	1.32	0.101	0.09	0.329	0.035	2.97	0.587	....	.....	....	.	46,000	2415 cal.—81 g. protein
9-10	860	1.026	585	10.38* 11.74	8.54	1.19	...	0.17	0.448	0.04	3.29	1.07	....	....	....	...	......	Treatment† 1776 cal.—58 g. protein
10-11	1530	1.020	336	14.31* 16.50	11.24	2.26	..	0.317	0.433	0.031	3.66	1.74	.	...	30.8	Temperature = 103°C. 9.1	7,830	1701 cal.—60 g. protein
11-12	1520	1.020	274	14.35* 16.07	10.30	3.36	.....	0.22	0.440	0.033	1.32	2.30	...	.	....	Temperature = 100°C.		2100 cal.—80 g. protein
12-13	700	1.020	385	8.10* 11.09	6.66	1.02	..	1.103	0.277*	0.03	0.74	1.60	.	.	....	...	......	2170 cal.—78 g. protein
13-14	580	1.020	330	7.50* 8.56	5.95	1.19	.	0.08	0.307	0.015	1.00	0.600	....	......		.	..	2022 cal.—80 g. protein
14-15	300	....	.	. .	.	. .	....	....	.....	....	0.51	.....	....	.... .	33.8	3.0		Put on high salt diet on 9/14/22
15-16	800	.....	. .	.....	.....	...	....	.....	.....	....	1.98	.....	70.0	+55.4				

* Total nitrogen calc. from fractions determined. † See radiation sheet. ‡ Patient on purine-free diet (see Experiments).

CASE III.—JULY 23-AUG. 14

TABLE III

RADIUM TREATMENT

Date	Amount, Mc.	Area	Screening	Time	Total Mc. hrs.	
8-2	158.4 212.5	Intrauterine	Silver, .5 Brass, 2 Rubber	5 hrs. 6 min. 5 hrs. 6 min.	1854.5	Radium

X-RAY TREATMENT

Date	Time, Min.	Area	Size Skin Area	Filter	Sp. Gp.	Ma.	Focal Skin Dose	Skin Dose	Per Cent. Depth Dose	
8-3	152 150	Abdomen Back	20×20 20×20	.5 .5	200 200	4 4	80 80	80 80	50 50	"Deep Ray" Therapy

TWENTY-FOUR-HOUR SAMPLES OF URINE, JULY 23-AUG. 14

Date	Vol.	Sp. Gr.	Tot. Acid	Tot. Nit.	Urea N	N.H.₃	Uric Acid	Creatinine N	Creatin N	Amino Acids N	Chlorides	Tot. SO₃	Inorganic SO₃	Ethereal SO₃ Calc.	Total P. Calc.	Inorganic P.	Organic P.	Gm. CO₂	Remarks	Weight 49	Basal M. +4.5
23-24	1280	1008	. . . . .	5.1655	. . . . .	. . . . .	.12	.217	.076	.075	3.888	1.093	.985	.1075	.3567	.35	.0067	.588	‡Proteins 44.4 gm.		
24-25	1290	1005	102	6.289* 4.290	5.0623	.642	.112	.2536	.0998	.091	3.	1.097	.614	.4832	.4265	.422	.0045	.0812	54.8 gm.		
25-26	1000	1015	155	7.539* 7.762	6.1163	.7047	.168	.2905	.1165	.115	3.27	1.599	.962	.6367	.645	.628	.017	.205	75 gm.	48	+ 7.5
26-27	1340	1008	178	6.299* 6.405	5.361	.387	.14	.235	.106	.067	3.43	1.367	.8924	.4746	.4450	.437	.0089	.0722	49.1 gm.		
27-28	2000	1011	166	8.787* 8.88	7.273	.707	.163	.3642	.0848	.123	5.7	1.646	1.206	.440	.6327	.618	.0147	.1811	49.9 gm.		
28-29	1570	1011	80	6.639	. . . . .	.5856	.156	.248	.130	.122	5.22	1.292	.785	.5071	.4029	.3910	.0119	.2968	55.7 gm.		
29-30	1040	.	. . . .	6.48* 6.59	5.073	.7417	.17	.248	.1409	.101	2.55	1.353	.8663	.4794	.527	.513	.0088	.2526	55.3 gm.		
30-31	1700	.	208.9	8.606* 8.43	7.061	.776	.190	.308	.134	.117	3.33	1.404	1.319	.085	.654	.638	.0157	.1983	55.7 gm.		
31-1	1135	1000	160	6.638	5.521	.4913	.15	.278	.085	.100	3.35	1.248	.880	.358	.418	.410	.0082	.1039	55.6 gm.		
1-2	1310	1011	134	7.287* 7.399	6.064	.480	.147	.300	.111	.121	3.19	1.244	.9825	.262	. . . .	. . . . .	.012	.3312	58.6 gm.	47.8	+ 0.2
2-3	822	1025	84.17	4.385* 4.548	3.598	.2579	.140	.2226	.0556	.0036	6.28	.895	.674	.221	.3881	.3803	.0078	.177	55.6 gm.	Treatment	
3-4	Lost																				
4-5	580	1018	145	. . . .	. . . .	. . . .	.23	.215	.0704	.111	.93	1.185	.812	.373	. . .	.327	.005?	.0417	5.6 gm.	Treatment†	
5-6	925	1000	170	5.39* 5.847	4.116	.554	.23	.244	.100	.103	.948	1.128	.673	.155	.375	.350	.025	.066	2.8 gm.		
6-7	1115	1023	182	6.691* 6.841	5.302	.5725	.23	.27	.129	.106	.714	1.326	.899	.427	.397	.378	.019	.0694	27.6 gm.		
7-8	630	1012	99.8	4.1* 4.42	3.263	.403	.07	.156	.0631	.057	.225	.9555	.6955	.26	.24	.232	.008	.046	31.1 gm.		
8-9	780	1012	159	5.888* 6.094	4.784	.556	.163	.242	.071	.08	.6	1.427	.995	.432	.343	.335	.007	.0122	36.6 gm.	45.7	+ 7.4
9-10	730	1010	127.3	5.158* 5.159	4.31	.437	.12	.208	.034	.078	.426	1.182	.795	.386	.296	.266	.03	.0397	40.7 gm.		
10-11	373	1015	106	4.17	3.075	.354	.06	.16	.026	.043	.144	.9548	.749	.2058	.232	.224	.007	.0202	51.9 gm.		
11-12	884	1010	181	5.511* 6.523*	4.151	.704	.143	.280	.107	.095	.39	1.335	.839	.496	.38	.36	.02	.048	39.1 gm.	46.0	+10.4
12-13	605	1009	80.4	3.941	2.903	.459	.15	.193	.063	.063	.42	.840	.496	.354	.129	.108	.016	.0327	60.4 gm.		
13-14	1065	1007	111.1	5.313	4.074	.528	.22	.292	.0855	.089	.768	1.118	.681	.4356	.238	.216	.022	.067	44.8 gm.		

* Total N.T. Calc. from different fractions determined. † Treatments—see Radiation Sheet. ‡ Diet—see Experiments.

The patient was anemic with 64 per cent hemoglobin and 3,100,000 red cells.

Experimental Period. The patient was placed on her special diet July 19th and collection of urine started on July 23rd. The diet was equivalent to about 1,500 calories with about 55 gr. of protein. This patient generally consumed only part of her diet and refused food for about three days after her *x*-ray treatment.

Discussion of Data. Due to the irregularity of the food intake, no definite conclusions concerning the nitrogen excretion can be drawn. However, judging from the increase of uric acid lasting for three days after the treatment, the data are in harmony with the two cases previously reported (Tables I and II). The greatest change in metabolism after radiation was the enormous retention of chlorides. The normal excretion of chlorides averaged 3.68 gm. per day with an average urine volume of 1,478 c.c., while, after the radiation period (calculated from the time the whole diet was again consumed) only 0.46 gm. of chlorine with a urine volume of 776 c.c. per day was excreted. No gain in weight or edema was observed during this period. The decrease in chlorides is, indeed, far greater than could be accounted for by the volume changes in the urine. Our data also shows that there is a marked decrease in the total amount of carbon dioxide excreted.

DISCUSSION AND SUMMARY OF EXPERIMENTS

The data obtained from these experiments, which cover the fields of both moderate and heavy *x*-ray therapy, confirm and enlarge the data of previous investigators, as regards nitrogen metabolism. The total nitrogen in all cases was increased in the postradiation periods. Of the different nitrogen fractions determined, the urea plus ammonia and the uric acid were the only ones which showed any increase. In the first two cases (Tables I and II) which had tumors that could be readily observed, the increase in the total nitrogen was parellel to the decrease in the size of the tumor. Since we also observed an increased excretion of phosphorous, it is very probable that a great part of this increase of total nitrogen was due to the elimination of destroyed cells. In this connection the increased output of urea and ammonia and of the undetermined nitrogen gives a partial insight into the mechanism involved in the decomposition of those cells destroyed by the radiation.

In Case I (Table I) the weight of the tumor mass before radiation was estimated at between 200 and 300 gm. It will be seen that there was an increase after the radiation of about 3.6 gm. of nitrogen, corresponding to 22.5 gm. of dry protein. Estimating that the average tumor tissue contains about 10 per cent protein and 80 per cent water it will be seen that 225 gm. of tumor tissue were actually destroyed.

These experiments also indicate that "roengten sickness" is not due to excessive cell catabolism, since Cases I and II having the largest tumors and greatest increased nitrogen excretion were scarcely inconvenienced by the *x*-ray treatments, while Case III, with the smallest tumor and lowest nitrogen output, suffered a very intense postradiation reaction.

The influence of radiation of the inorganic metabolism was most unexpected, in that in all cases a marked retention of chlorides was observed, a retention far greater than could be accounted for by a possible retention of fluids. This is clearly demonstrated in Cases I and II where no decrease in urine volume or gain in weight could be observed. In fact the retention of chlorides was so pronounced in Case II, that not even forty-eight hours after a high salt diet was there a very marked increase in the chloride output. In Case III, although the urine volume decreased one-half, yet the chloride excretion was eight times below its normal value without any gain in weight. How long this chloride retention would have lasted could not be determined in these cases, but animal experiments are in progress which we hope will clear up the mechanism and factors involved in this phenomenon. The changes in the chlorine metabolism are summarized in the following table:

TABLE IV

	Volume before Radiation	Volume after Radiation	Chlorine before	Excretion (Cl) after
Case I	924 c.c.	899 c.c.	7.7 gm.	2.06 gm.
Case II	1319 c.c.	1341 c.c.	4.5 gm.	1.94 gm.
Case III	1487 c.c.	776 c.c.	3.68 gm.	0.46 gm.

In conclusion, we wish to express our thanks to Dr. B. H. Schreiner and Dr. Th. Mueller of the State Institute for the examination and treatment of Cases I and III. We also wish to thank Dr. Rochester and Dr. Koenig of the Buffalo General Hospital for the use, observation and treatment of Case II. We are indebted to Dr. Bowen for the basal metabolism determination and to Dr. Reimann for the leukocyte counts.

BIBLIOGRAPHY

1. Folin and Wright. *J. Biol. Chem.*, 1919, xxxviii, 461.
2. Van Slyke and Cullen. *J. Biol. Chem.*, 1914, xix, 141.
3. Folin, Otto. *J Biol. Chem.*, 1914, xvii, 469.
4. Folin, Otto. *J. Biol. Chem.*, 1919, xxxviii.
5. Pucher, G. W. *J. Biol. Chem.*, 1922, lii, 317.
6. Benedict and Franke. *J. Biol. Chem.*, 1922, lii, 387.
7. Folin, Otto. *J. Biol. Chem.*, 1922, li, 393.
8. Folin and MacCallum. *J. Biol. Chem.*, 1912, xi, 523.
9. Whitehorn. *J. Biol. Chem.*, 1910, xlv, 449.
10. Benedict, S. R. *J. Biol. Chem.*, 1909, vi, 363.
11. Bell and Doisey. *J. Biol. Chem*, 1920, xliv, 55

DEEP ROENTGEN THERAPY AND SKIN REACTIONS

BY P. DEL BUONO, M.D.

Director of the Roentgen Department, Clinica Spinelli per la Terapia dei Tumori

NAPLES, ITALY

THE expressions *radiosensitivity* and *selective action* of a cell or group of cells, with respect to *x*-rays, have not yet acquired a sufficiently definite meaning to be of practical value.

We know, however, that increasing the dose to a definite value, that is, exceeding the limit of tolerance of an organic territory, invariably produces an injury of the skin. With some degree of approximation, therefore, we can establish a criterion of relative vulnerability in the so-called erythema dose previously determined. But it is not uncommon to find that a patient who has been irradiated under the same conditions as many others, will show a few hours or a few weeks after treatment, a skin lesion of variable degree, from a premature erythema which soon disappears, to a burn of the second or third degree which may take several months to heal. If we exclude the possibility of error in technique, and can prove that this patient received the same dose as many other patients, how can we account for the origin of the lesion? Does this patient exhibit a special sensitivity to the injurious action of the rays? Neuwirth reports that a patient lost her hair completely after irradiation for a gynecological condition. Is this a selective diminution of the resistance of a tissue under the action of the rays?

The question of the existence of a *specific* idiosyncrasy for the *x*-rays has often been discussed. The consensus of opinion is that such an idea must be set aside for the following reasons: The pathological phenomenon of idiosyncrasy occurs for minimal doses of the drug or element which brings it about, and its effect, in the organism in general, is manifested by a shock. Feeble doses of *x*-rays should then produce skin lesions which should result in severe burns, ulceration, and extensive necrosis. No one has observed such changes following small doses of *x*-rays. We believe we can exclude the statements of many radiologists who have mentioned idiosyncrasy for *x*-rays in connection with some cases which showed an erythema, a burn, or even an ulcer after short exposures for radiographic purposes.

This important question was discussed at the Tenth Congress of Radiology, in Germany. The general conclusion was that a true idiosyncrasy for *x*-rays does not exist. Wetterer and Schmidt were most emphatic in this belief. The appearance of a lesion following the use of *x*-rays for a diagnostic purpose is to be attributed to the use of a beam of rays with too large a proportion of very soft radiation, or to the use of too short a target-skin distance. The recommendation was made that a filter of leather or aluminum and a distance of at least 40 cm. should always be used.

But we cannot deny the existence of hypersensitivity and hyposensitivity to *x*-rays. However, we must not confuse this abnormal reaction of an irradiated tissue with absolute specific and selective radiosensitivity. There exists a physiological equilibrium in the cells of a tissue, and if no external cause has disturbed this equilibrium, all the cells should respond in the same manner to an external agency, such as *x*-rays. It is true that the action of *x*-rays on a cell depends on the age of the cell, but this does not explain why a tissue becomes necrotic after the application of a dose of radiation which was harmless to the same tissue in another case. The existence of a disease, a toxemia, or a nutritional disturbance or local weakness of the tissue can explain its greater sensitivity to the rays. Zieck describes the case of a patient whom he irradiated for tabes mesenterica with two doses of 180 F (Fuerstenau units) in the course of fourteen days. The radiation was measured with the Fuerstenau intensimeter and the dose certainly was not large, yet the patient developed very serious abdominal burns. In this case, the patient had little resistance to disease and had undergone many operations (cholecystotomy, gastroenterostomy, appendectomy, nephropexy).

The skin of children is very sensitive to *x*-rays, whereas the skin of very old individuals is less sensitive, and can stand sometimes 100 per cent larger doses than normal. The skin of blondes, and especially of Titian blondes, shows a marked vulnerability, while a dark skin is more resistant. Also different skin areas exhibit different sensitivity to radiation. Seitz and Wintz give the following scale of skin sensitivity: neck, abdomen, thighs, shoulders, face. They conclude, also, that healthy skin does not show variations greater than 10 to 15 per cent in its reaction to *x*-rays.

In the literature of the last few years are reported several cases which developed burns following irradiation, which cannot be attributed to faulty technique. Kurtzahn irradiated the knee-joint of a patient owing to a mistaken clinical diagnosis of surgical tuberculosis. A short time later, a serious burn developed, with ulceration and finally, perforation of the joint. The histological examination of the tissue revealed an old trichinosis. Evidently this had so weakened the tissue that it was unable to stand a dose of less than 50 per cent of an erythema dose. Bogrow and Grintchar attributed the great sensitivity to *x*-rays of tuberculous patients to the tubercular toxins, since no other explanation could be found for the lesions which they obtained. Numerous radiologists have found that when the sacrum is irradiated, the anal fold undergoes a more marked pathological change than the neighboring parts. Not uncommonly, small, therapeutic doses for the treatment of eczema have caused an erythema and burns of the second degree. This may be explained by the fact that the skin of the anal region is weaker and therefore, less resistant to external actions. Seuffert, Warnekros and others point out that syphilis, even if it is not localized, nephritis, diabetes, and diseases of the blood-vessels predispose an individual to *x*-ray burns.

From what has been said so far, we may conclude that predisposition, or the abnormal state of such a delicate tissue as the skin (on account of disturbances due to nutrition, growth, or change, no matter how caused) may render intolerable doses of *x*-rays which for other individuals are therapeutic doses.

It is not our intention in this paper to establish a scale of injuries caused by various doses of *x*-rays. It is well known that the appearance of an early erythema does not necessarily indicate that a burn will follow, although some radiologists have asserted this to be the case; neither is a late injury which appears after many years necessarily preceded by healed burns. Between these two skin effects, as reactions to *x*-rays, there can be no connection, for it is not always evident that there is a single causative factor. If there were, a sure means to avoid it would have been found. If these effects were due to too large a dose, or to the quality of the radiation, a physical criterion would have been established, which we should not attempt to exceed. But we have noted serious burns where the skin showed previously no alteration whatever, not even the dry state indicative of the limit of toleration of normal skin.

The appearance of an early erythema a few hours after radiation has been attributed to too hard *x*-rays and too prolonged radiations. This can be denied *a priori*, because, in dermatological practice with small doses of soft radiation, early erythema is not rare. It has been shown that the harmful effect of the radiation is identical for soft or hard rays. Here again we must consider predisposition toward the appearance of early erythema on the part of the radiated tissue. According to Breuer, this is not to be attributed to heat, ultraviolet rays, fluorescence, or electric shocks, but to the fact that the vascular system of the tissue is unsound, so that it responds to even small doses with the appearance of an erythema.

The characteristics of this early erythema are its sudden appearance a few hours after radiation, and its disappearance after a few days without special treatment. Its origin is to be sought in the predisposition of the tissue, which, for some reason, not being able to react sufficiently, is liable to be injured by doses not otherwise harmful.

If, however, as we have stated above, there can be no connection with respect to the quantity and quality of the radiation between a very slight early reaction and a conspicuous later one, such as a burn or ulcer, and we look for the origin of these injuries, we must conclude that they can arise only in tissue which has lost, wholly or in part, its ability to defend itself against external disturbances, such as *x*-rays. In this sense, the cause of the cutaneous injuries is an alteration of the underlying tissue by constitutional, nutritional innervation, or, more properly, trophic disturbances. Thus we observe such an injury in tissue which has already been damaged and rendered incapable of defence, either externally, by excessive dosage, or internally, by local or constitutional diseases; in a word, by any cause which may disturb the equilibrium of the cellular system.

Radiologists have been endeavoring to establish the nature and cause of the cutaneous injuries by every possible means. Histological investigations of the various skin strata show that it is the vascular system which suffers most from the radiation. Not that other elements, such as the lymphatics, the fat, and connective tissue, are indifferent to the action of the rays; but, as Rost, Reimer, Scholtz, David, and others have shown, it is the blood-vessels which are easily affected, almost selectively, by the radiations. When these have lost their power of defence, changes in the radiated tissue may even proceed to necrosis. The nuclei of the cells and the network of chromatin are immediately affected by the rays. Evidently every harmful action cannot be the same for every cell, but must depend on the constitution of the cell itself. Those nuclei are most easily affected which are in a state just preceding, during, or immediately after the process of division. The affected territory suffers before a true lesion occurs. The process of healing is longer and more difficult the larger the number of newly-formed cells which were affected and the more serious the injury to them. This may explain why *x*-ray burns do not heal readily. We find the selective action of the rays on the young elements also in the blood-forming organs and embryonal glands. Dermatologists have made use of the selective action of the radiation, for a long time. For instance, if they wish to obtain a permanent epilation, they pull out the hairs four or five days previous to the radiation. By this epilation the regenerative power of the hair follicles is increased, and thus the rays are better able to exercise their destructive action on the newly-formed elements.

The endothelial cells of the blood-vessels are selectively radiosensitive, as indicated by the observation that when the skin is exposed to small doses of *x*-rays, the cells of the epithelium show no change, while the endothelial cells of the blood-vessels immediately beneath the skin show signs of injury. For larger doses, the epithelium, the fixed connective tissue cells and the lymphatics are injured. It is the vascular endothelium which will recover last.

The capillaries of the corium are affected by very small doses. The first consequence is the loss of elasticity, so that the vasomotor apparatus no longer functions well, and the skin is handicapped in its power of resistance. For larger doses, the lumen of the capillaries becomes smaller, even to obliteration, or an extravasation may occur, with subsequent telangiectasis. The effect on the skin is shown by the appearance of an erythema, that is, with atrophy and pigmentation. When the injury to the tissue reaches a certain intensity, a visible reaction occurs on the skin; according to Kienbock, the degree of reaction for the same area of normal skin depends on the quantity of rays absorbed.

The erythema manifests itself only after the lapse of a certain time, the so-called "latent period." Here we must exclude early erythema, the cause for which is to be found in changes in the tissue previous to radiation. The latent period is the pathological course of the injury caused in the tissues, especially the more radiosensitive elements, namely, the small vessels. In normal tissue, it depends, first of all, on the specific radiosensitivity of the cells. It is shorter for rays of medium wave-length and longer for rays of short wave-length. At the end of the latent period, a definite change in the skin appears, which may vary from a slight pigmentation to a serious erythema. There is a boundary between a rather intense erythema, which, however, heals easily and may be considered as physiological, and one more intense, which is really pathological. This limit is determined by the regenerative power of the cells. A dose which exceeds this limit causes serious alterations. This limit of vulnerability may be reached in two ways. An excessive dose of radiation may have acted on the tissue so long that serious changes may have been brought about, especially in the blood-vessels, so that the nutrition of the irradiated tissue is interfered with. Such a lesion manifests itself after a very short latent period, with a strong erythema, pronounced burn, and tissue necrosis. It is stronger, the heavier the irradiation. In this class are to be included all the serious burns due to gross errors of technique; for instance, omission of the filter, or error in the length of treatment. We may point out that it is useless to ascertain whether hard rays are more injurious than soft, since an excessive dose of any type of rays will occasion such dangerous burns, and the injury is not caused by a special quality of the rays. The tissue thus affected will cease to function, and after months of care a painful cicatrix will form.

But skin injuries may be caused in other ways. As far back as 1911, Iselin mentioned the cumulative action of *x*-rays. Immediately after radiation with small doses, slight alterations are found in the more radiosensitive tissues, namely the blood-vessels. Scholz, in particular, studied these changes microscopically, and found, even on the seventh day, degeneration of the lining of the large capillaries and swelling of the cells, with amitotic nuclear division, up to a partial or total obliteration of the vessels. Recently, David has gone over this work, and, by means of microscopic examination of the capillaries *in vivo*, has noted the smallest changes in the vessels immediately after irradiation. He has established thus that vascular changes are visible under the microscope long before they manifest themselves macroscopically. The vascular elements of transition from arterial to venous swell considerably as a first reaction, while the arterial and venous capillaries are dilated *in toto*. David observed these changes even two days after irradiation, where gross changes were noticeable only after six or seven days. But the most interesting part of these researches is the observation that in tissue areas, which, for any reason, are less resistant than the normal, the changes in the vessels are systematically premature, and present the same characteristic picture. In nephritic subjects, such changes as will take six days in the normal individual to manifest themselves, are visible after three days with an equal dose of radiation. This observation holds good not only for nephritics, but also for vagotonics, and is seen in Basedow's disease. The skin of these patients recovers more slowly than the normal from the effects of the same dose. That the vessels are influenced immediately has been demonstrated by Mayer, who observed signs of degeneration in the iris, retina, and eyebrows when radiation was used in the neighborhood of the eye.

Skin necrosis does not occur easily when the blood-vessels are injured by *x*-rays. In the first place, all the vessels are not injured to the same extent, and for doses which do not exceed certain limits, the tissue, although its blood supply is limited, tends to recover. The more distant blood-vessels have remained uninjured, and those which have been affected gradually recover and contribute to the nutrition of the tissue.

The same criterion of cumulative action as in the case of poisons cannot be presupposed here. The cells of the blood-vessels, through selective action and other elements of the cutaneous tissue, such as the lymphatics, fat, the fixed connective tissue cells and sweat-glands, are affected, but not in the same degree. If a second irradiation does not follow the first, the skin gradually recovers; that is, first the germinal layer of the epidermis and the hair follicles, second the fixed connective-tissue cells (which, according to Rost, are also seriously affected) then the sweat-glands, and finally all the papillary endothelium, recover. With a new irradiation, even with a smaller dose, the less sensitive cells, which have had time to heal, are able to stand it; but the more strongly affected cells, whose power of defence has been reduced, are further retarded in their recovery, and the resultant lesion may be made worse. The regenerating power of certain skin elements is quite different from that of others. While in three or four weeks the epidermis has healed, the endothelium is still seriously affected. A new dose acts as an extra dose in the sense that it makes the condition of the blood-vessels worse and impairs the nutrition of the tissue. The cumulative action of a series of small doses bears a relation to the latent period for weak doses of *x*-rays. The injury from each individual reaction may be too slight to produce an inflammatory reaction, but the sum total of many small doses can cause a real dermatitis.

Having thus established that the primary injury is to the vascular system, we can understand Reimer's assertion that the less blood a tissue contains the more resistant it is to *x*-rays. Hypoemic skin is less sensitive to *x*-rays (Schwartz), inflammation and consequent hemorrhage increase its radiosensitivity. Schwartz radiated skin previously made hyperemic and obtained an erythema in half the time required for normal skin. Wieting records better results, and avoided serious injuries to the skin by tying the arteries surrounding the tissue to be radiated, providing this area were relatively circumscribed. Lenz and Richter proved that skin made hypoemic with adrenalin is more resistant to the rays, and can withstand for three weeks a double dose of soft rays or a triple one with hard. From these experiments with adrenalin, and the clinical observations of Reimer and others, we may deduce how alteration of the cutaneous vessels by innervation increases intolerance of the cell to the rays. Adrenalin acts on the extremities of the sympathetic nerves and causes vascular constriction; in this sense the tone of the vessels is increased and they are able to offer greater resistance to any external cause. In the contrary case, that is, when, due to innervation of the sympathetic, the tone of the vessels is lowered, it is evident that the vessels must suffer also, and therefore become less resistant to the rays.

Reimer has studied clinically the course of slight *x*-ray injuries in patients in whom he suspected the vascular system to be abnormal, due to innervation. He has reported several important cases, from which the author concludes that when there exists any weakness of the vessels, small doses of radiation may cause serious injuries. De Boer found that after the interruption of the connecting sympathetic branches, atonia is observed in the corresponding muscular system, whereas the reflex of the tendons remains unaltered, or even increases. Reimer observed the same phenomenon in those of his patients whose vascular system was abnormal.

They showed a special hypersensitivity to normal doses of *x*-rays, extensive ulceration resulting, in some cases. One case described in detail is that of a young woman who had vasomotor troubles from youth (menstrual disturbance, irritability of the vessels, pronounced dermographism, slight tachycardia, hemicrania, sudden and profuse perspiration). Her father had been afflicted for many years with cephalalgia, angina pectoris, and had died of apoplexy. Her muscular tone was low, whereas the tendon reflexes were increased. With this patient, as with many others of the same class, serious cutaneous injuries were caused by small doses of rays which would not have caused noticeable alteration in the skin of normal patients. What part in *x*-ray injuries is played by innervation of the sympathetic, cannot be specified at the present time. But the observations of Reimer deserve attention, also the better known fact in *x*-ray practice of the relation between thyroid trouble and skin injuries. It is well known that in the treatment of struma only very small doses may be used. One-third of the ordinary dose will produce a skin effect.

We have seen that there is a cumulative action for *x*-rays. But if we give the proper dose in one treatment, or even repeat it at very long intervals, there should be no more serious burns. Bearing this in mind, it follows that to deliver a sufficient dose to a deep-seated tumor without serious injury to the skin, we must employ heavily filtered radiation produced by a high voltage and applied from a suitable distance.

Radiologists disagreed from the time this method began to be used. Regaud and Nogier distinguished two different types of skin reaction; one, a local inflammation of the epidermis, that is, a radio-epidermatitis, caused by the hard rays, which was quite different from the radiodermatitis caused by the soft rays. The former is superficial, heals more quickly, causes little discomfort, and does not have such serious sequelae as the latter. Bumm and Warnekros were of the same opinion, and, in 1914, published an article that aroused great controversy, because the smallest dose they used in treating uterine carcinoma was at least four times as large as the strongest doses previously used; yet they found no skin troubles except an ordinary reaction, wet dermatitis and excoriations with a tendency to heal readily.

The danger of using many weak doses has led physicists to obtain more penetrating radiation, and now with heavy filters and a considerable distance from the anticathode, it is possible to administer in one sitting a dose which is considered to be sufficient. The skin thus thoroughly radiated cannot remain unaffected; the vessels are subject to serious alterations and are partly destroyed; the lymphatics and the fixed connective tissue cells are injured. But the same skin area is not subjected any longer to radiation; its nutrition is maintained by the few vessels remaining intact, and, although the healing process is slow, we are sure there is no danger of serious skin injuries. We always notice that after a strong irradiation the skin becomes dry and sometimes brittle, and the radiated territory may appear swollen.

Seitz and Wintz, in discussing a case of severe burn described by Heimann, state that the thickening of the skin which always occurs after irradiation constitutes a certain degree of injury. This slight degree of injury due to the hard rays is of no consequence. It remains present for a considerable length of time, causes little or no discomfort, and never proceeds to necrosis. However, this zone must never be irradiated again, otherwise necrosis will follow. In Heimann's case, that part of the skin in which infiltration appeared was irradiated a second time.

Muhlmann attempts to give a physiological explanation of skin infiltration as a consequence of radiation. He has observed this effect in cases treated with both soft and hard radiation. It is more constant and more noticeable in cases treated with small and frequent doses than in those irradiated only once. The adipose tissue of the skin has a tendency to chronic inflammation in the form of induration, which is observed also in cases where the skin showed only an ordinary pigmentation. The radiosensitivity of a tissue may be taken to increase with increase of its fat stratum, and, therefore, the infiltration is greater and more characteristic in those parts of the body where, physiologically, there is accumulation of fat, especially if the fat be covered with flabby and spongy skin (lower abdomen of old women, region below forehead and jaw). The development of a callus seems to begin immediately after irradiation, and through external causes (compression, trauma) may be painful.

In this connection we may report an observation of Regaud and Nogier. External trauma or trauma caused by operation is not dangerous soon after the irradiation, but it may become so if it occurs a long time after the irradiation. As the vessels and other radiosensitive elements are not injured, trauma may cause no trouble. Later, however, complications may arise owing to changes which have taken place in the irradiated tissue. The course of callous infiltration is extremely chronic; with a larger degree of inflammation necrosis may set in. It is probable that ulcers of the skin caused by radiation, even when not followed by erythema, must be ascribed to this action on the adipose tissue. Muhlmann concludes his observations by advising the administration of only two-thirds of an erythema dose on skin areas having considerable adipose tissue, and the attempt to compress, if possible, the surface to be irradiated by means of a suitable bandage. After three to five months the edematous regions which are not radiated again become normal in consistency and function.

Jungling tries to account otherwise for the nature of this skin edema. We may observe injury to the lymphatics, especially to the endothelium, which is very permeable and readily causes lymphatic stasis. These lymphatic elements possess a relatively large radiosensitivity, for edema thus accounted for is observed in many cases when the skin remains intact or slightly altered. A histological study shows that edema is principally localized in the papillary stratum; the capillary vessels and the lymphatic rifts dilate and show many leucocytes in the periphery. The edema is undoubtedly of an inflammatory nature. The constant perivascular infiltrations which are apparent even with small doses are present many months after irradiation. The infiltration is due principally to the swollen fixed connective tissue cells, from a few lymphocytes and leucocytes. With a larger dose, the edema increases in the reticular layer, with a swelling of the papillae, up to the separation of the epithelium, with the appearance of an injury between the epidermis and the papillary layer. According to the authors, these changes can still heal readily, provided no additional radiation is administered during the healing process.

All these observations and conclusions which have been subject to argument from the beginning of superficial *x*-ray therapy down to the present day of deep radiotherapy, are but the analysis and synthesis of injuries which appear on the skin owing to the correct or mistaken application of a beam of radiation. The erythema dose used as a criterion corresponds to a certain point in the aforesaid scale of injuries, and our technical skill should enable us (1) to reproduce at every irradiation a predetermined skin reaction of certain and easy recovery, readily withstood by the patient, and (2) at the same time, without injuring the surface, to deliver a strong dose of *x*-rays at the desired depth.

Different schools have adopted different degrees of erythema as the standard skin dose. The criterion of skin vulnerability, since it cannot have a pathological limit in the absolute sense, is differently interpreted. Opinions differ as to the degree of the skin lesion which is permissible.

The erythema dose adopted by Seitz and Wintz is that skin change which, caused by hard rays, appears soon after irradiation as a slight redness. After three weeks it has a darker coloration, and in about six weeks is followed by a decided bronzing. They have correlated the biological dose with the reading of a physical instrument. They found that a dose which measures less than 35 units of their electrometric system will not produce the above-mentioned skin changes, whereas a dose of more than 35 units produces a more severe reaction, with a possibility of first degree burns.

Kroenig and Friedrich, following their numerous experiments on tadpoles and on the human skin, employing rays of different composition, adopted, as a biological unit of radiation, an erythema dose. This they could measure by means of an electrometric system of their own. The skin changes which they obtain with their unit dose are much more marked than those of the Seitz and Wintz unit. The erythema dose of Kroenig and Friedrich is identical with the so-called inflammation dose of Opitz, which, in the human subject, produces simply an inflammation of the first degree, accompanied by temporary reddening. From 170–180 "e" of their electrometric units give rise with considerable constancy to the above-mentioned reaction, whereas with 210 "e" a second degree erythema is produced, with excoriation of the skin, and, in many instances, with vesication.

For Warnekros, the definition of an erythema dose in the sense described by Seitz and Wintz, and Kroenig and Friedrich, cannot constitute a definite criterion which can be applied with certainty to every case. He finds in the amount of radiation necessary to produce the reddening and later tanning of the Seitz and Wintz dose, a difference of 30 to 40 per cent in different patients. He irradiates very powerfully, and his criterion of maximum skin dose is that which produces a pronounced dark red coloring of the abdominal skin, with papular separation of the epidermis and a profuse secretion from the raw surface. This dose, according to the author, is greater than the so-called "carcinoma dose" in the ratio of 100–85; the carcinoma dose is thus defined, since it produces a biological effect on carcinomatous glands situated immediately below the surface. The action of so strong a dose on the skin is not serious, and Warnekros states that he has no special injuries to record. The irradiated skin has a tendency to heal readily, and without some special cause there should be no ulceration or necrosis. With this method the entire dose of radiation is given in one sitting. Should thickening of the skin and subcutaneous tissue be observed in ten to twenty weeks, this will become normal. But there is always the question: Can we, under all conditions of technique, duplicate our dosage? That is, can we always use a beam of rays whose physical properties are identical?

A matter which is becoming of great interest is that of *x*-ray injuries which appear after some lapse of time—the so-called "late effects."

It seemed, after the introduction of hard rays in radiology, that the danger of burns was past. It was believed that the skin could withstand a greater amount of radiation as the filtration was increased. But later, after a very long time, burns were noted. There are cases described in the literature in which severe skin injuries appeared five to six years after treatment, although in no case was excessive dosage used, and it seldom exceeded the erythema dose. However, the evidence points to the fact that in every case, successive doses were administered at short intervals, two to four weeks, and in order to attain the dose considered destructive for cancer tissue, 5–8–10 consecutive treatments were given. The origin of these late injuries, which occur only with strongly filtered radiation, is not to be ascribed to the nature of the rays themselves, but to the selective radiosensitivity of certain skin elements, as we have already seen.

In *x*-ray therapy as practiced some years ago with weakly filtered radiation, the radiologist could note the appearance of a burn as soon as the maximum dose tolerated by the skin was exceeded; when this did not occur, it was evident that the skin would always remain sound, for the rays were so slightly penetrating that the vessels situated below the skin were not damaged. The contrary is true for more penetrating radiation, for it is possible to give strong doses at a depth without injuring the skin. The skin which has been submitted to such strong radiation not only should not be radiated again, but should be protected from external injury (trauma) which may impede nutrition and delay or stop the process of recovery. There should then be no danger of late burns, since the steady improvement in the circulation and the recovery of the vital functions of the elements of the tissue cannot possibly account for the formation of late ulcer and necrosis. But this is not true if, at the time of recovery of its normal functions, the tissue be radiated again. The injury may not show itself immediately: years may pass; but finally, neither the defensive strength of the organism in general, nor the assistance rendered by the neighboring tissue, can save the tissue and prevent slow necrosis.

No other explanation of late injuries can be found, and the cases recently described in the literature cannot be interpreted otherwise. Waelsch reports the case of a patient who, nine months after the irradiation, was affected by a third degree radiodermatitis. On the skin of the face and neck were left typical scar formations with telangiectasis and hyperkeratosis. The author states that recently a carcinomatous formation developed in the middle of the scar in the cheek. We wonder what part the injury of seventeen years before played in the development of this carcinoma. We are of the opinion that this cannot be dissimilar to *x*-ray carcinoma, which is caused originally by slight and slow radiodermatitis, and may develop uninterruptedly and cause death, as in the case of many radiologists, or it may remain latent for many years, and then, owing to obscure external or internal causes, give rise to irreparable injuries.

We may call attention to the fact also that in the treatment of neoplasms or lymph-glands in the neck by crossfire, we can, without producing any change on the surface, produce at a depth, where the beams overlap, those injuries to the vessels and other elements which we have already described. This crossing of beams of radiation with accompanying dangerous increase of dose, can also take place when the Roentgen-Wertheim method is used. It is important to note that injury may arise from overlapping beams which, separately, would not be dangerous.

Detailed statements of the importance of the physical nature of the rays in deep therapy have been made by Rost, Kroenig and Friedrich, and Seitz and Wintz. The histological examination of tissues injured by radiation led Rost to assert that the injuries are of similar character in every case, whether they are produced by radiation of long or short wave-length. The degree of biological action is dependent on the amount of radiation absorbed in a unit volume of tissue, whence serious injuries may arise from the administration of small doses of soft rays. Kroenig and Friedrich, after many experiments, arrive at the same conclusions. According to them, the biological effect of unfiltered *x*-rays and of those filtered by 1 mm. of copper is equal for equal doses; the biological effect of rays filtered by 8 mm. of aluminum or 1 mm. of copper is equal for equal doses. The same authors were able to establish the difference in biological effect for various intensities of radiation. With a difference in intensity of 1 :8 the magnitude of the biological reaction is dependent on the intensity of the radiation; for equal doses the effect is stronger for the more intense radiation. For a difference in intensity of 1 :5 the biological reaction is independent of the intensity.

During the last few years, since the war, we have noted a new factor contributing to the uncertainty of deep *x*-ray therapy. Skin burns appeared with no apparent cause. Skilled therapists excluded overdosing, predisposition, and every other cause heretofore mentioned. It has been shown that variations in the primary voltage may cause such changes in the tube voltage as to give considerable increase of dose, sufficient to account for all types of injury. Poor coal and defects in the electrical distributing system cause line fluctuations between afternoon and evening from 170 to 250 volts. This is sufficient to cause a good deal of trouble, unless proper precautions are taken.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.

Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.

Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-FOURTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

CHICAGO, ILL., SEPTEMBER 18, 19, 20, 21, 1923

Headquarters, Meetings and Exhibits: Congress Hotel, Chicago, Ill.

A VISIT TO SOME SOUTH AMERICAN RADIOLOGISTS

BY JAMES T. CASE, M.D., F.A.C.S., D.M.R. & E. (CAMB.)

Battle Creek Sanitarium

BATTLE CREEK, MICHIGAN

EARLY this year it was my privilege to make a journey to the principal cities on the Atlantic Coast of South America in connection with the cruise of a group of Fellows of the American College of Surgeons. On board the "Van Dyck" of the Lamport & Holt Line we sailed from New York on Feb. 10, 1923, calling for a stay of from one to five days in each of the following ports, in the order named: Havana, Panama, Cartagena (Colombia), LaGuayra and Caracas (Venezuela), Trinidad Island, Rio de Janeiro (Brazil), Santos and Sao Paulo (Brazil), Buenos Aires (Argentina), Montevideo (Uruguay), Rio de Janeiro again, and Bridgetown (Barbadoes, British West Indies). Official recognition of the mission of the North American Surgeons was forthcoming from each of the republics visited, the president in each instance except Colombia personally receiving us and our wives at an appropriate occasion. Cordial greetings were extended by the medical profession of the various countries, individually and through the Faculty of Medicine of the University in each city. In Rio, Buenos Aires and Montevideo formal meetings of the Fellows of the College of Surgeons were held in conjunction with the medical or surgical societies, the program being supplied by speakers both North American and South American.

It is difficult for the citizen of the United States who has not visited the wonderful cosmopolitan cities of the southern half of the New World to appreciate their beauty, their culture, their effort to keep abreast of the rapid advances made in medical science in other parts of the world. Indeed, even for one who has all his life been interested in things and doings Spanish, there was a very distinct though agreeable surprise in realizing a visit to such a wonderfully beautiful city as Rio with its million and a quarter inhabitants, Buenos Aires, a second Paris, with nearly two million inhabitants, and Montevideo with four hundred thousand population. We are told that the West Coast cities are not one whit behind in culture and in the natural beauty of their surroundings, and it is our hope one day to achieve a visit to the principal cities of Chili, Peru, Bolivia, Ecuador and the capital of Colombia. Aside from their other charms, all these important South American republics should attract our attention because of their economic and political importance in relation to the future of our own republic. Brazil has twenty-five million inhabitants speaking Portuguese; Argentine twelve million Spanish-speaking people largely influenced by Spanish, French, Italian, and German ideals, not only in general, but also in relation to medical and surgical practice. The same is true of Montevideo and the republic of Uruguay. More purely Spanish are the West Coast republics, Lima, Quito, and Bogota being considered among the principal seats of Spanish language and literature on the American Continent.

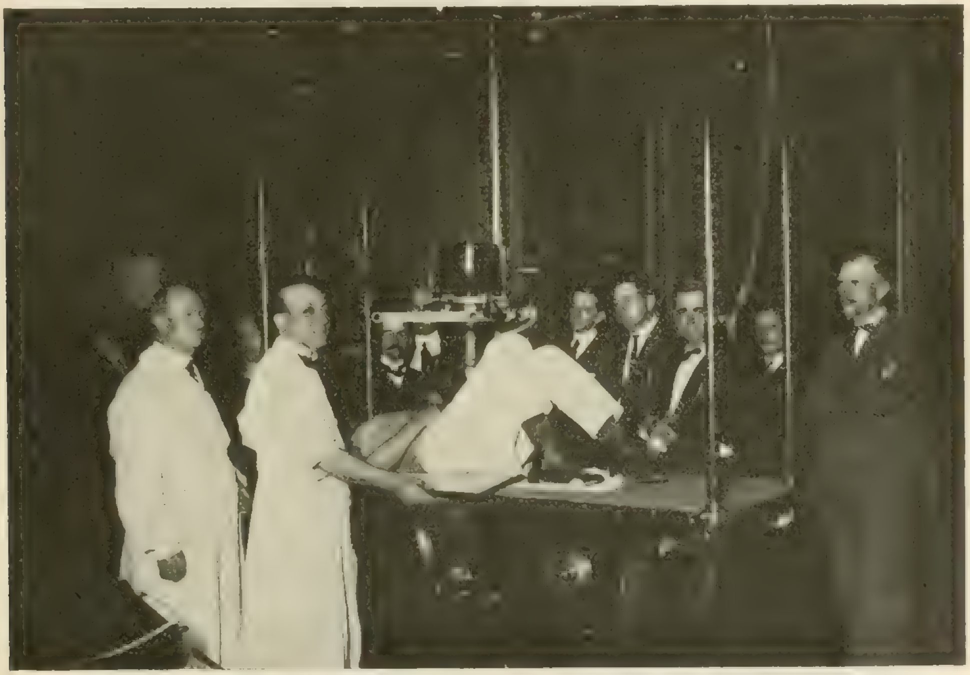


Fig. 1. A scene in the laboratory of Dr. Humberto Carelli, Buenos Aires.

Not only were the surgeons of the College Mission received officially and individually with the greatest cordiality, but those of us who have occupied ourselves largely with roentgenology were accorded a special welcome by the radiologists in each of the cities visited. Especially warm was the attention given Dr. Emil Beck and myself as members of the American Roentgen Ray Society by the radiologists of Buenos Aires and of Montevideo. Every possible facility was afforded for our entertainment and enlightenment as to South American ideals and practice in roentgenology.

In Buenos Aires the "Sociedad Argentina de Radio y Electrologia" held a special session in honor of our visit, on March 16, and the following evening at the famous Jockey Club tendered a banquet to "Dr. J. T. Case and his American Radiological Colleagues." At the society meeting, the president, Professor Alfredo Lanari, in some elegantly worded remarks, voiced the warmth and cordiality of the hospitality which they wished to extend to us, and invited the writer to take the chair as presiding officer of the evening. Dr. Heuser and Dr. Carelli, as well as most of the other speakers, seconded the cordial welcome of the president. The following program will convey some idea of the scope of interest of our southern colleagues in radiological work.

1. James T. Case. Radiological Exploration of the Duodenum (In Spanish).
2. A. and E. Lanari. Hydatid Cysts of the Lung (In Spanish).
3. Humberto Carelli. On Pneumoperitoneum in the Diagnosis of Abdominal Hydatidosis (In English).
4. J. A. Saralegui. Results in Deep Roentgen Therapy (In Spanish).

5. Carlos Heuser. Demonstration of Cases Treated with Deep Therapy (In English).

6. C. Donovan. Radiological Exploration of the Lumbo-Sacral Spine (In Spanish).

FIG. 2. Waiting room in Radiological Institute of Dr. Carlos Heuser, Buenos Aires.

7. F. Merlo Gomez. Demonstration of the Carelli Table (In Spanish).

Dr. Beck was called upon for discussion of several of the communications.

Professor Lanari and his brother gave a well-illustrated discourse on pulmonary hydatids and their differentiation from sarcoma. The diagnosis of hydatid cyst of the lung is one of the earliest and most brilliant triumphs of radiological investigation. (It should be mentioned that hydatid disease is very common in the Argentine. There is scarcely a surgeon of consequence that does not operate upon some scores of cases of hydatid disease yearly and among these the number of pulmonary hydatids is not inconsiderable.) In a case clinically suspected of a pulmonary hydatid the absence of a suspicious shadow permits the immediate rejection of such a possibility; but when on the contrary the radiological examination presents shadows of a character usually considered characteristic of hydatid disease, is the diagnosis assured? By no means, for there must be a differentiation between hydatid cyst shadows and the various other tumors and diseases which may produce abnormal shadows in the thoracic roentgenogram. The most easily confounded diseases are mediastinal sarcoma, interlobar pleurisy, pulmonary gangrene, pleural effusion, dermoid cyst, and pulmonary abscess.

Pulmonary hydatid cysts usually present shadows highly characteristic of the disease, and the diagnosis is usually simple either with the film or with the screen. This is especially true in dealing with central cysts giving uniform shadows of variable size, rounded or oval, and with well-circumscribed borders surrounded by healthy, cortical tissue. The translucency of the surrounding lung tissue makes the typical opaque shadow of the cyst stand out characteristically. In the presence of a shadow giving such characteristics, the diagnosis offers no doubt; but it frequently occurs, especially in some of those cases where cysts have undergone purulent infection, that the cyst shadows do not present all these characteristics on account of the reaction of the surrounding tissues, resulting in pleural or pulmonary processes which mask the typical shadows. In the majority of cases there will remain some free portion of the cyst not covered by this obscuring process. In others, however, the surrounding reaction materially complicates the diagnosis.

In differentiating pulmonary hydatid cyst from the intrathoracic conditions already mentioned, the history and the clinical signs play a very important part. Dermoid cyst and pleuropulmonary hematocele are, in the Lanari opinion, not distinguishable roentgenologically from hydatid cyst, although some authors have tried to make differentiations. The radiologist simply can confirm the presence of a shadow of a cyst. Certain forms of pleurisy naturally offer confusion, especially the encysted pleurisies, and above all those shadows with rounded contours. The patient should be examined in various positions and from various angles to make the differentiation as complete as possible.

Pulmonary sarcomas frequently present the characteristics of hydatid cyst. This

Fig. 3. A group of American visitors in Dr. Heuser's laboratory, Buenos Aires. Dr. Heuser in white gown, indicated by X.

is true when they are found in the midst of the clear pulmonary field with the well-defined border well known to us all. The differential diagnosis is difficult. Of the differential signs, a few may be mentioned: (1) The intensity of the shadow. In equal volume, the sarcoma is always more opaque than the cyst. It is more difficult to distinguish the ribs through the shadow of a sarcoma than of a cyst: not a very valuable evidence, it is granted, yet it is possible to make it of importance. (2) Another sign is an apparent connection with the mediastinum. Sarcomas generally originate in the connective tissue of the mediastinum and one can trace a connection between the tumor and the mediastinal shadow. When neither the intensity nor the apparent connection of the mediastinum permit confirmation of the diagnosis, it is well to wait for a while, watching the radiological evolution of the tumor to see if new signs may not develop. (3) Ordinary sarcoma grows more readily than cyst. The author does not wish to say that this difference can be observed in a little while. Sarcoma sometimes grows slowly, and in more than one case he has found that many months after the first examination it was difficult to prove any appreciable increase in volume. There comes a time, however, when the sarcoma commences to grow brusquely and suddenly, and then the diagnosis is cleared. He believes this is a sign which is sooner or later observed in all sarcomas. When on repeated observation of a presumed hydatid of the lung, there is found a sudden change in size and form of the shadow, which cannot be explained by the clinical symptoms as a reaction to purulent infection, one must reject the diagnosis of cyst in favor of sarcoma.

Fig. 4. Photograph of Dr. Humberto Carelli, Buenos Aires.

Professor Lanari is chief of the Department of Physiotherapy in the University of Buenos Aires, his laboratories being located in the Hospital de Clinicas, just across the street from the School of Medicine. Here was found an amply, though not recently, equipped radiological institution, with new apparatus for deep therapy about to be installed.

Dr. Carelli's name is very familiar to most American radiologists, and especially to the readers of our Journal, because of his work on pneumoperitoneum and perirenal emphysema, an extended account of which was recently published in these pages. The special advantages of the pneumoperitoneum method, above all when carried on by the aid of the elaborate and ingenious table constructed by Carelli for the purpose, is easily apparent in the search for abdominal hydatidosis, the resulting improvement in the percentage of correct diagnoses approaching that for lung hydatidosis. One can scarcely imagine a demonstration of a larger number of more interesting roentgenograms, of such a high average quality from the technical standpoint, than were included in this very instructive exposition.

Carelli, like Heuser, is engaged in private practice, the private institutes of these men being models from the standpoints both of art and of equipment for high-class work. I understand Carelli is to be associated with the work of Professor Arce, the leading surgeon of Buenos Aires, in the new Institute of Surgery of the University of Buenos Aires, one of the most perfectly-equipped surgical institutions in the world. Here, for the first time, I found a public teaching hospital with an equipment ideal from the roentgenological standpoint.

The next paper, by Saralegui, the secretary of the Argentine Radiological Society, was an account of his personal experiences in the new deep therapy. I saw some of this radiologist's work at the Rivadavia Hospital—some neatly performed and illuminating cases of pneumoperitoneum.

Carlos Heuser followed with a lantern-slide and patient demonstration of some of his deep therapy results, his cases in every way demonstrating that in his degree of success he was not one whit behind the work I have previously seen in France and Germany, and quite equal to the success of any radiologist in North America. This speaker had gone to no end of trouble to provide a rich clinical demonstration.

Heuser urges the fact that the rays bring about a cure through their physical effect on the neoplastic cells, as they destroy the colloidal action. Through the vibration of the ray the organism of the cell is dismembered, resulting in a fall of the nucleus outside of the cell and the reabsorption of the dead cell's organism. This results in the destruction of the cells that receive sufficient vibration to kill them; in the lack of which a recurrence of the disease ensues and the cancer redevelops. The foregoing remarks explain why, in many instances, we apparently cure the disease, and yet if the cells are not within the zone of efficient radiation, they are not completely annihilated and reproduce themselves easily in a weakened constitution. Heuser is of the opinion that the radiologist ought to submit cancerous patients to treatment prior to operation so as to destroy partially the malignant cells and thus render them less reproductive. When such a tumor is removed we probably extract one that is not so liable to reproduce itself. By this process better cures will be obtained than by treating the patient during other stages, such as after the operation.

The type of rays employed should be suited to the cells. Some cells are cured with soft rays, others yielding to hard ones. Furthermore, there are certain cells which cannot be destroyed except by other biological means.

Statistics show that the probability of improvement depends upon the location, the class of cell in each location, the condition of the patient's organic activities, and lastly, on the procedure which has been followed to attempt a cure of the cancer.

Fig. 5. Photograph of Dr. Carlos Heuser, Buenos Aires.

Heuser submits as highly valuable data such cases as the prostate, the uterus, sarcomas and carcinomas of large cells. However, in-so-far as carcinoma of the throat, tongue and stomach are concerned, it is not possible to obtain permanent cures, although temporary improvement is achieved extending over a period of a few months. The carcinomas which dissolve rapidly and contract a second infection move very swiftly, while those which disappear gradually are more readily cured.

In regard to uterine fibroids, Heuser succeeded in reducing the volume by 80 per cent, and for the remaining nucleus he recommends removal, since it is difficult to forecast developments within four or six subsequent years. On his records he has 3 cases of fibroid tumors which were treated between 1912 and 1914, all of whom died in 1921—one as the result of a sarcoma of the lung, another due to cancer of the rectum, and the third in consequence of a sarcoma of the uterus. For this reason he feels that we should remove whatever tumor tissue remains in the abdomen.

Because of lack of time Dr. Donovan consented to have his paper read by title, and the entire audience adjourned to the new Surgical Institute above referred to, where we witnessed the working of the new model of the Carelli table. Those of my readers who did not read Carelli's article in the April issue of this JOURNAL will do well to look it up; there they will find numerous illustrations of the various advantages afforded by the new table.

At the banquet the following evening toasts were proposed by President Lanari and responded to by Dr. Beck and the writer, and Drs. Carelli, Donovan, Saralegui, Edward Lanari, La Marque, Ustenghi, Heuser, and Barragué. In the course of the remarks I heard an explanation of the fact that the Argentine radiologists do not seem over-enthusiastic about their hospital work. We had observed that in the various hospitals (with the exceptions above mentioned) the radiological department seemed to be given scant attention in the way of equipment, and there was a corresponding limitation to the radiological work done, both as to quantity and quality. It seems that in the majority of hospitals, the roentgen-ray departments are regarded as of secondary consequence, and there is therefore but little inducement to work in many of the sanitary establishments where complaints on the part of the radiological workers go unheeded.

The Argentine speakers declared that they were all seeking to achieve success in the cure of cancer by means of the roentgen rays. Unhappily, although it was true that some cures had been attained, they "have not yet emerged triumphantly from the struggle" and are not "as enthusiastic as the Germans" in curing cancer with the *x*-rays—not because they do not utilize the same appliances and identical methods, but because they feel it is "best to reveal the naked truth." They feel, however, that they have made great strides, and today can achieve apparent success where failure hitherto followed their efforts.

All joined in expressing the hope that the friendly relations existing between the radiologists of the northern and the southern continents may become still closer, leading to an "ideal union, working for the cure of the ills which afflict humanity, in an altruistic and generous spirit." Repeated expression was given to the pleasure experienced by our hosts in extending to us their cordial greetings, and, through us, to our colleagues of the American Roentgen Ray Society their grateful thanks for the many courtesies which they receive during their periodical visits to the United States of America.

Dr. Carelli and Dr. Heuser both arranged for visits to their private establishments, as well as to their homes, and to them and their most charming ladies we and our ladies owe a great debt of thanks. As before suggested, the Radiological Institutes of these two gentlemen (the only ones in Buenos Aires I had an opportunity to visit) are models of their kind. A large group of surgeons from the Cruise took advantage of the courtesy of these doctors to witness demonstrations of their technique in deep therapy and in pneumoperitoneum work, especially in the perirenal emphysema of Carelli. For this special work, Carelli is now employing an "oxygenateur du Dr. R. Bayeux" manufactured by Richard of Paris, the maker of the "Verascope Richard," a stereoscopic camera which many of us have admired and used.

In connection with the formal meeting of the American College of Surgeons at the Faculty of Medicine, under the presidency of Professor Arce, the rector of the University, papers were contributed by the college through Dr. Hugh Young of Baltimore and the writer. Dr. Young's paper, given partly in French, concerned the surgical removal of the prostate for various conditions, while the writer's paper, in Spanish, concerned the employment of the *x*-rays in the postoperative management of surgical cases, especially in the early determination of postoperative ileus, the study of fistulous tracts, studies after gastroenterostomy and other gastrointestinal operations, and for the correct collocation of splints, sounds, drainage tubes and catheters. As I pointed out ten years ago, it is possible to save patients from death by ileus every year in every hospital in the land by the routine employment of bedside apparatus in the study of patients on the third day after abdominal and pelvic operations. It is not necessary to administer barium; simply place a large film with screen underneath the abdomen of the patient, and make a short exposure with the bedside apparatus. The resulting roentgenogram will reveal evidence which is very valuable in confirming or denying the presence of postoperative ileus, for if it exists, there will be an easily discernible distention of the small intestine with gas, the distended coils reaching such proportions that the diagnosis is clear in the great majority of instances without the administration of opaque material.

On arrival at Montevideo, I found a delegation of Uruguayan radiologists waiting at the dock. I was carried at once to the office of Dr. Pedro Barcia by his associate, Dr. Mezzera, where I found a large array of patients awaiting my examination. They were chosen from the cases selected for operation in the surgical clinics planned for the visiting surgeons during the next three days, and I was asked to check over and confirm or deny the findings prior to operation, and then "face the music" during the operative sessions. The experience was a bit of an ordeal, but nevertheless a great pleasure, and one I shall long remember. I saw 4 cases of hydatid cyst of the lung before the fluoroscope that afternoon, besides a long list of other important cases of surgical interest.

Dr. Barcia is a very hard worker, very intelligent and keenly interested in the advancement of radiological work in his country. He and his partner, Mezzera, have a well-appointed private clinic where they work literally from early morning till late at night. Excellent deep therapy technique was practiced here, as well as in the institute of Dr. Carlos Butler, who is associated with Noguiera, a urological surgeon. Barcia, like many of the Argentine radiologists, employed American apparatus for his treatment work. Indeed, a very large proportion of the radiological equipment in the southern countries was of American manufacture.

Dr. Belliure is another radiologist and physiotherapist of Montevideo who was extremely courteous to the American visitors and who deserves special mention for this fact.

Carlos Butler is one of the long-established radiologists of South America. His work has been known to us for many years. He holds the chair of Radiology in the Faculty of Medicine of the University, and is director of the University Institute of Radiology. I had the pleasure of spending a morning with him in the University Institute of Radiology observing his work and looking over his records of past achievements with radium and roentgen therapy. Butler, like most of the other South American radiologists of prominence, has studied much in Europe, and on the therapy question especially in Germany, and he apologized for not having visited us here in North America, on account of his unfamiliarity with English and the rarity of Spanish-speaking radiologists in this country. However, since the United States participated in the Great War many of our radiologists have acquired a speaking knowledge of French, in which language all South American physicians are able to speak, so that this drawback to visits from our Southern confreres should no longer hold. We sincerely hope that all will feel welcome to our shores and to our clinics at any time.

Again, in Montevideo, it was my privilege to deliver addresses in Spanish on two occasions—once in the Medical School on "Some Phases of the Treatment of Hyperthyroidism," and in the amphitheatre of the "Maternity Hospital" a discussion of the "Radiological Study of the Duodenum." Our hearers were generous in their appreciation of our effort to speak in Spanish, and again expressed through me to the American Roentgen Ray Society an appreciation of the greetings which I brought to them in the name of my colleagues of the society, and of the great advances being made in this country in radiology, both in diagnosis and in therapy, and of the help which this work has been to our colleagues in Uruguay.

All too soon we had to continue on our way to other countries. Rio de Janeiro deserves special mention for the work of Dr. Duque Estrada and his associate, Dr. Campello. Estrada is connected with the Medical School of Rio. I had a brief chat with Estrada on the down voyage when we stopped at Rio, and planned to have much more time with this talented radiologist, but he was called into the interior of Brazil and I failed to see him again. His colleague, Campello, was most assiduous in his attentions, and did all in his power to add to the pleasure and profit of our visit.

Dr. Toledo Dodsworth, known to us in this country through his personal visit to our clinics several years ago, was absent from Rio at the time of my visit.

Portuguese was none too easy to manage, but by speaking Spanish and French, it was possible to make our friends understand perfectly, and Portuguese is so similar to Spanish that it was reasonably easy to understand them.

We did not have time to meet the radiologists in Sao Paulo, but we must mention one man in particular there who is doing excellent work: Dr. Raphael P. de Barros. Neither did we visit Bahia nor Pernambuco. Bahia is the home of Dr. de Souza da O', director of the Department of Radiology of the Faculty of Medicine of Bahia. This radiologist is well known to us by his publication on radiotherapy, "A Cura Dos Fibromas Pelos Raios X," which is an excellent treatise of the subject of the treatment of myomas of the uterus.

Other well-known South American physicians whose names are prominent in radiology are: Dr. Rafael Gonzalez Rincones of Caracas, Venezuela, Dr. Oswaldo Portugal of Sao Paulo, Brazil, Dr. Becerro Bengoa of Montevideo, Uruguay, Dr. Adolfo Kaplan of Santiago, Chile, Dr. Ducchi of Santiago, Chile, Dr. Esteban Compodonico of Lima, Peru, Dr. Luis Becerra of Lima, Peru, and Dr. J. A. Cavelier of Bogota, Colombia.

I have no doubt that I have overlooked a number of names which should have been mentioned; but surely any South American reader of this article will appreciate that it is difficult for one individual in such a short time to cover the ground. Neither have I mentioned the valuable work which is being done in Cuba where there is a large group of men doing excellent radiological work. I was especially kindly treated by Dr. Alfredo Dominguez, one of the port physicians and also a radiologist, who greeted me on the boat just after we entered Havana Harbor, as did Dr. Pedro Farinas, Dr. Rivero, and Dr. Cabrera Benitez. I hope to have the pleasure very shortly of renewing my acquaintance with the Cuban doctors and of furnishing an account of their work to the readers of our JOURNAL.

CORRESPONDENCE

To The Editor:

I am very grateful to Dr. Sheldon for his kind letter[1] in reply to my note respecting his article in the April number of the JOURNAL; and am interested to learn that with his apparatus he finds E_0, the unfiltered erythema dose, is only 2, in the units there used. He refers to the table given in the paper by Drs. Witherbee and Remer as confirming this value. The reference is unfortunate. They maintain that the effect varies as the first power of the spark-gap; he regards it as varying as the square of this gap; also, they define the erythema dose by four different sets of values. Using these values in Dr. Sheldon's expression, $mam \times G^2/D^2$, we find the values: 2.11, 4.21, 3.16 and 6.33. The first of these is the one chosen by Dr. Sheldon; but if we accept his expression as correct, the variations in these numbers are to be ascribed to errors in observation, and their average should be chosen as the best expression of the results of the observations on which they are based. This average is 3.95. Values of this order are to be found in the U. S. Army X-Ray Manual and other publications. It was for this reason that I chose, for purely illustrative purposes, the non-committal, round value, 5, in my note; it agreed with no one, but seemed to be of the proper order of magnitude. It is to be expected that individual determinations of this quantity will show very appreciable variations, depending upon the peculiarities of the subjects, the judgment of the observers, instrumental errors, variations in technique, etc. When observations for determining the effect of the filter are expressed in the manner proposed by Dr. Sheldon in his original paper, these variations are included in that effect and there is no way in which they can be satisfactorily disentangled from it. But if the observations are expressed in the manner I suggested, all effects arising from a fixed error in the quantity R (such as a lead leakage that does not vary with the intensity of the current) will be segregated in the quantity E_0; all effects causing a fixed percentage error in R (such as one subject requiring 10 per cent more radiation than another) will introduce the same per cent error in E_0, in a, and in b. Thus a mere inspection of results obtained by different laboratories, when expressed in this manner, enables one to classify them as regards the natures of the relative errors involved, to pick out those most suitable for study, and to determine the true effect of the filter. It was for this reason, rather than for the purpose of securing an increased precision in the computation of doses within the region of filtration covered by Dr. Sheldon's observations, that I proposed a change in the formula; but incidentally the change permits a more accurate computation for filters less than one millimeter thick.

---

[1] AM. J. ROENTGENOL., June, 1923, x, 502.

Ernest Dorsey.
Washington, D. C.
June 23, 1923.

OFFICERS OF THE CENTRAL ILLINOIS RADIOLOGICAL SOCIETY

At a recent meeting of this society the following officers were elected:

President: James H. Finch, M. D., Champaign, Ill.

Vice-president: Harold Swanberg, M. D., Quincy, Ill.

Secretary-Treasurer: P. B. Goodwin, M. D., Peoria, Ill.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal (69 *East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Birkelo, C. C. Bilateral calcification in the Fallopian tubes. *J. Radiol.*, Mar., 1923, iv, 92.

The author reports an unusual case of a woman with a clinical diagnosis of tuberculosis of the right kidney. An *x*-ray study of the genitourinary tract was requested. This examination revealed two small round shadows in the pelvis, one 3 cm. to the left of the median line and the other 4 cm. to the right of the median line and both 7 cm. above the symphysis. These remained in the same position following catharsis, and a diagnosis of calculi in the lower ureters on both sides was made.

An operation was then performed, a median incision being made. There were numerous pelvic adhesions and the fimbriated ends of both tubes were involved so that the lumen was closed in each. The calculi described in the *x*-ray were found, one in each Fallopian tube, and removed. The right ureter was found to be about the size of an adult's middle finger, tortuous and tuberculous. The right kidney was not tuberculous.

It appears that all of the symptoms originated in the tuberculous right ureter and that the calculi found in the tube were not the cause of any pain.

McClure, James, and Claremont, H. Ethelberta. Case of inverted pylorus obstructing a gastrojejunostomy aperture. *Lancet*, Apr. 14, 1923, cciv, 750.

A search of the literature has failed to reveal the report of any case similar to that described in this article. This case was that of a young woman, aged twenty-two. The post-mortem examination revealed the following remarkable condition. The pylorus had evidently been divided surgically at a previous date and a posterior gastrojejunostomy had been performed. There was an interval of about two inches between the pyloric end of the stomach and the duodenum. On opening the stomach the invaginated portion of the stomach was seen to be about an inch and a half in length hanging down in the form of a pedunculated polyp into the gastrojejunal aperture and almost blocking it. This case illustrates the danger of invaginating too long a portion of gut, thereby forming a polyp; in this instance it caused an obstruction to the outlet of the stomach. It is possible that in other situations, for example in a lateral anastomosis after resection of intestine, a terminal invaginated portion might similarly be a potential source of obstruction. Knowledge of the possibility of this accident may assist the roentgenologist in explaining some obscure cases of difficulty after gastroenterostomy.

Grynfelt. Post-traumatic osteoporosis of the bones of the extremities (improperly called atrophy by the radiologists), *Archives D'Electricite Medicale et de Physiotherapie* 124, Apr., 1923.

The author has recently reported two important studies on the subject of the title of this paper, one before the Society of Medical Science of Montpellier and the other at the Academy of Sciences in 1921.

Repeated examinations and the careful studies undertaken with a scientific rigor, of which the name of the author is a guarantee, lead him to some new and previously unreported conclusions.

From this important work, which is eminently instructive, the editor of the Archives extracts the following, which to the radiologist should be of special interest:

1. Demineralization, calcareous atrophy, decalcification—terms habitually employed to designate the particular alteration of bones following traumatism, manifested on the roentgenograms by an increase of the transparency of the bone, and diminution of the clearness of the images furnished by the bony trabeculae, are such improper terms that we should reform immediately in our use of them in the light of the facts set forth by the author.

2. Osseous atrophy of the skeleton appearing suddenly near or at a distance from the initial lesion (more often a more or less infected fracture) is not calcareous atrophy. The clinical, radiological and histological studies of the author prove this clearly.

3. In cases of bone atrophy the amount of fundamental mineral salts is equal to the percentage found in normal bones.

Kjaergaard, S. Operative versus radiological treatment of fibroids. *Acta Gynecologica Scandinavica* I: 191, 1922.

This is an interesting discussion of the pros and cons concerning the operative or radiological treatment of fibroids. The basis of the *x*-ray treatment is undoubtedly the risk of the operation and above all the danger of death from it. In this particular case the term radiological refers to the *x*-ray treatment alone. The applications were always made in several series with about three weeks of interval, in the majority of cases the treatments varying from four to six weeks. The treatment was applied to large areas, two abdominal ones in the case of the smaller growths and four in the case of the larger. In a number of instances sacral areas were also employed. Amenorrhea has usually made its appearance after the second or third application, occasionally before and sometimes later. After amenorrhea was observed two or three further applications were given, partly to insure that the amenorrhea was permanent and partly to act further upon the fibroids.

Of 84 cases treated with radiation 7 are especially mentioned by the author. Of these the reviewer will refer to one where the treatment was employed temporarily as a preparation for operation, the hemoglobin increasing from 30 to 70 during two months, after which total hysterectomy was performed, the tumor being no less in size.

Another interesting case was a woman of forty-six who for a year and a half had suffered from menorrhagia attended by pain. She was found to have a uterine tumor the size of a child's head. There was nothing to suggest a malignant growth. Under *x*-ray treatment amenorrhea was established and the tumor decreased to the size of an orange. Seven months later she submitted to operation which revealed a capsulated mixed-cell sarcoma of which she died a year later with metastases.

The author summarizes the value of *x*-ray treatment in fibroids as follows:

In a very large proportion of suitably chosen cases the hemorrhage can be controlled (statistics show 90 per cent and more, even close up to 100 per cent). A shrinkage effect on the tumor is less certain, and this applies particularly to certain types (subserous, intraligamentory, cervical fibroids). With *x*-ray treatment one runs the risk of an unfortunate mistake in diagnosis and this treatment may sometimes be a source of immediate danger.

It will thus be perfectly evident that it is of great importance to choose correctly between operation and *x*-ray treatment.

INDICATIONS

There are some types of cases in which the *x*-ray treatment is out of the question, such as infected and necrotic, twisted and incarcerated fibroids; also fibroids requiring treatment during pregnancy and those which give rise to intraperitoneal bleeding. In the case of fibroid polypi which can be shown to be situated in the vagina or at the os uteri, it is agreed that operation is the best treatment.

X-ray treatment should be as far as possible avoided in complicating infections of the appendages, as there is a risk of a dangerous exacerbation. A careful exploration of the appendages is often rendered difficult when fibroids are present, especially in the case of the larger ones. A favorable history as regards infections of the appendages is therefore particularly desirable.

On the other hand, the non-infectious salpingo-oophoritis so frequently found in association with fibroids, hydrosalpinx, etc., is not a contraindication of *x*-ray treatment. In summing up the complications in operation cases which are unsuited for *x*-ray treatment this is often included, but experience shows it to be unjustified.

If there is another lesion in addition to fibroids which demands operation, particularly ovarian tumors, it will be wisest in most cases to remove the fibroids at the same time.

A very important contraindication against *x*-ray treatment is the presence of malignant ovarian tumors, and sarcoma and carcinoma of the uterus. Such complications are not very rare in patients with fibroids (Freund 6.2 per cent, Klein 7.7 per cent, Machenrodt 7.7 per cent).

The author concludes by expressing his well-founded impression that indications such as those he has advanced will determine that the majority of patients ought to be operated on, and the minority—30 to 40 per cent—ought to be treated with *x*-rays.

Beuttner, O. Radium treatment of uterine cancer. *Schweiz. med. Wchnschr.*, Feb. 1, 1923, liii, 105.

During the last eight years the author has treated 63 cases of cervical carcinoma with radium. On the basis of this series he believes that the result of radium treatment depends less on the type of carcinoma as determined with the microscope or the exact dosage than on the age and general condition of the patient. The older the patient the better the results. The prognosis of carcinoma in women comparatively young has improved through radium treatment. The author has been much interested in Kotzareff's experiments on fixation of the emanation in embryonic and malignant cells, and hence has employed radioactive bodies given intravenously. On the basis of his experience the author believes that even if it is still an open question as to whether operable carcinomas should be removed surgically or treated by radiation, nevertheless, better results in inoperable cases are attained by irradiation than with the older palliative methods.

Besser, Herman. Actinomycosis of the lungs simulating tuberculosis. *N. York Med. J. & Med. Rec.*, May 16, 1923, p. 623.

The clinical and physical signs of pulmonary actinomycosis cannot be differentiated from tuberculosis. The disease begins with a gradual onset. A cough develops, accompanied by expectoration of a yellowish, white sputum. There is an afternoon rise of temperature and night sweats soon follow. There is progressive loss of weight, accompanied by malaise and debility.

Pulmonary actinomycosis differs from tuberculosis in its morbid anatomy in that the disease spreads by continuity. In the early period of infection the disease manifests itself in the formation of small miliary tubercles which later coalesce and form large masses. They take on the appearance of a malignant growth of the lungs, and unlike tuberculosis, ignore anatomical boundaries. The infection spreads to the pleural sacs, causing an adhesion between both sacs and finally rupturing through the intercostal spaces and involving the rib structure. Necrosis of the rib develops and resembles a caries of the bone.

The history must be taken into account when interpreting the roentgen findings. The author cites a case in which the clinical and physical findings pointed to a frank, active tuberculosis, but the marked involvement of the lungs and the suppurative process of the ribs, as shown by the *x*-ray, pointed to actinomycosis. This diagnosis was substantiated later by the appearance of abscesses on the chest and back.

Pryor, J. H. Immobility of the diaphragm, with report of cases of bilateral immobility. *N. York Med. J. & Med. Rec.*, cxviii, 1923, 75.

The author has dealt with 145 cases in which there had been a pleurisy with effusion or empyema. The cases were classified as follows: (1) empyema in the child, (2) empyema in the adult, (3) pleurisy with effusion, (4) pleurisy with effusion and clinical pulmonary pneumonia, and (5) pneumothorax and effusion.

In approximately 16 per cent of cases it was found that the diaphragm remained unimpaired; another 16 per cent exhibited restricted motion on comparison of the two sides; and in 66 per cent of the cases there was complete immobility of the diaphragm on one side.

Fixation of the diaphragm was more commonly a sequela of empyema in the adult than in the child. Empyema is therefore a far more serious condition in the adult. Of 50 cases observed, only 8 showed no immobility or injury to the diaphragm.

Of the 6 instances of bilateral immobility, all were cases of chronic tuberculosis; all the patients had had pleurisy. Shortness of breath was a prominent symptom. On roentgen examination there was observed flattening of the dome of the diaphragm so that the pericardial attachment formed the angle of an inverted V. The heart shadow was long and narrow, its original shape being entirely lost. All these patients became steadily weaker and died in a short time, only one living for two years.

Quinby, W. C. Perirenal insufflation of oxygen. *J. Urol.*, 1923, iv, 13.

Not all authors agree on the value of the method of perirenal insufflation of oxygen as described by Carelli. Several critical reports have been published, and the author states that the procedure does not give the plates any greater value than stereoscopic roentgenograms made by the aid of the Bucky diaphragm. As to dangers, if the operator has ordinary judgment and anatomical preparation he will not run the risk of mediastinal emphysema or penetration of the bowel. Quinby describes his apparatus and his technique of injection, which is quite similar to that already published by Carelli. One new point by Quinby is his advice to inject the kidney pelvis and to make an *x*-ray exposure from twelve to fourteen hours after the gas insufflation.

The principal contraindication to such perirenal insufflation is the existence of dense adhesions about the kidney such as follow an operation.

Austrian, Charles R., and Baetjer, Frederick H. Some unappreciated findings in the lungs of normal children. *Am. J. M. Sc.*, June, 1923, clxv, 831.

The authors found in the study of normal children that variations from the usual accepted findings in health were often present, and it is their purpose to emphasize the need of evaluating such findings as physiological and not as evidence of disease. The study was based on some 200 apparently normal children between the ages of six and ten.

As a part of the report of a research committee for the National Tuberculosis Association, particularly interesting to the roentgenologist is the statement that inasmuch as shadows noted in roentgenograms of the chest of healthy children are dependent often upon alterations that persist as the residua of past infections of the respiratory tract, it is obvious that a careful anamnesis with special reference to all infections is necessary if diagnostic errors are to be avoided. Even a history carefully taken is often unreliable, as minimal infections are soon forgotten by many and among the unintelligent classes even more significant indispositions are not readily recalled. With a proper appreciation of the widest variations that the normal may present from the ideal, the informed clinician is better able correctly to understand the findings of the roentgenologist, and each, cooperating with the other, is less liable to error.

THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. X OCTOBER, 1923 No. 10

RADIUM TREATMENT OF TOXIC GOITER WITH METABOLIC DEDUCTIONS*

BY R. E. LOUCKS, M.D., C.M.

DETROIT, MICHIGAN

IN order that the true significance of a pathological condition or dysfunction of the thyroid gland may be understood, it is absolutely necessary that the anatomic relation with physiologic function and normal metabolism should be known, with a comprehensive understanding of its relation to the other endocrine glands.

Anatomically the gland consists of two lobes connected across the second and third ring of the trachea by an isthmus. The posterior surface is in contact with the thyroid and cricoid cartilages, the inferior laryngeal nerve, the inferior constrictor of the pharynx and the lateral borders of the trachea and esophagus. The outer surface is covered with the superficial muscles of the neck and the external jugular vein. The outer border of each lateral lobe is in close proximity to the carotid sheath containing the common carotid artery, the internal jugular vein and the pneumogastric nerve. The significance of this relation is apparent when dealing with any one of the enlargements of the gland.

The physiological function appears to control the iodin and calcium balance and split up iodin products into thyroxin (Kendall) which acts as a hormone stabilizer to the whole endocrine chain. The one or the many hormones have specific function in cerebration of the brain cells, increasing the activity of nerve transmission and regulating the heat mechanism; in fact, they are the main activators of metabolism.

Normal metabolism signifies a harmony in all the functions of the living body that go to make up a "well being." A physiological activation is not by any means a pathological hyperactivity.

The question arises: When is a hyperactive thyroid a pathological disease? The answer: When symptoms of toxicity are manifest, either objectively, subjectively, or by laboratory calculations.

Suffice to note that a toxic goiter may be:

1. A primary exophthalmic,
2. A toxic adenoma,
3. A toxic adenoma with exophthalmos.

1. The objective symptoms are manifest in the exophthalmic type by (*a*) the prominence of the eyeballs, giving a staring expression and a facies of mental alertness, (*b*) a lagging of the upper lid in looking down so that it apparently covers more than its half of the eyeball when closed. At times the lids cannot cover the ball completely but leave a slit allowing the conjunctiva and cornea to become injected from exposure, lack of palpebral lachrymation and massage. A strip of white sclera shows between the cornea and lower lid when the eye is open. (*c*) There may also be winking, tardiness of external ocular muscles and decreased lacrymation. (*d*) At times a red tremulous tongue is found and also teeth notched on the lateral borders.

---

* Presidential Address read at the Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

The primary exophthalmic type may not show any noticeable change either in size or figure of the gland, while the adenomatous type presents variations in size, from the large prominent uneven mass to small lobulated cystic out-croppings on the lobes or isthmus.

Pulsations of the thyroid arteries are common and a bruit may at times be heard over either lobe. The radial pulse varies from 90 to 160 and often registers much less than the apex beat, as each wave does not have time to be carried independently.

The heart may be enlarged in all diameters and if the case is of long standing there is evidence of myocardial degeneration, as elicited by the degree of fibrillation and the character of the murmurs present. The precordial impact may be diffuse, and have enough force to cause a heaving of the chest wall with each contraction of the heart. Pulsation of the superficial arteries of the fingers and toes is common.

The systolic blood-pressure in primary exophthalmic cases is at first raised, but gradually returns to normal or goes below normal after the first crisis. Should a spontaneous cure succeed, it remains low; but should a second crisis occur it again rises and remains high until the termination of life, unless treatment controls the toxicity. The diastolic blood-pressure is usually low, giving a much increased pulse pressure.

Trophic symptoms occur as a brownish yellow pigmentation of the skin, thinning of the hair and longitudinal striae of the nails.

Mental disturbances are common in the late or very active cases and vary from a state of constant fear and apprehension to that of a decided psychosis.

2. Subjectively, the individual complains of nervousness, general weakness, palpitation, insomnia, pulsation in the ears when lying down, sweating of the hands and feet and, at times, general hyperidrosis. Frequently digestive disturbances occur, such as nausea, loss of appetite and diarrhea; menstrual irregularities in females; pain and pressure in the neck with a sensation of choking, or an irritable cough, and general feeling of "fag."

3. Laboratory calculations are most conclusive in the toxic state. Du Bois has standardized basal metabolism in the normal individual and Plummer has proven by extensive studies that thyroxin in excess raises the metabolic rate. Therefore, a sufficiently high metabolism is pathognomonic of thyroid hyperactivity and is one of its most important diagnostic features.

With hyperactivity of the thyroid, there is marked increase in cellular activity and carbon dioxid output, with a speedy demand for larger oxygen consumption. To determine the metabolic rate it is necessary only to measure the amount of oxygen consumed for a given period of time, and make calculations in calories per hour, by comparing the intake to certain physiological standards for body surface, temperature and barometric pressure.

Urinalysis reveals kidney changes in direct relation to cardiovascular degeneration and digestive disturbance. Scanty, high-colored urine signifies concentration due to evaporation and skin elimination. Albumen and casts are indicative of kidney dysfunction and contraction. The presence of sugar indicates diminished carbohydrate toleration.

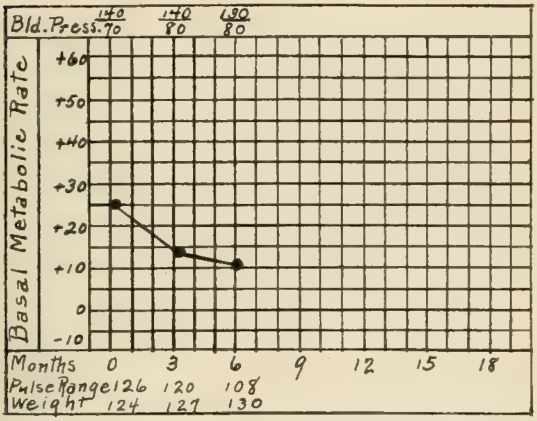
The blood picture may reveal a decreased number of erythrocytes with lessened hemoglobin content or an increase in leucocytes with a larger percentage of lymphocytes and eosinophiles.

Blood chemistry shows an increase in blood sugar only, which is provided by the thyroid for an increased heat production. If the blood sugar rises slowly there is a compensatory function of the kidney that holds the balance, and there is no glycosuria. Should this tolerance be broken by increased carbohydrate ingestion, the kidney excretes sugar.

An editorial in *The Journal of the American Medical Association* for April 14, 1923 (page 1071) after discussing the roentgen rays and surgery in the treatment of exophthalmic goiter, says: "In the light of the present-day evidence, the choice of therapeutic procedure presents, indeed, a difficult perplexity."

We are positive that no one treatment will control all cases of toxic goiter, but that after defining and correlating the symptoms and classifying the case pathologically, the indications for treatment should be manifest.

Furthermore, special consideration must be given to the associate or subsidiary symptoms before and after treatment. It is generally agreed that rest and quiet are helpful factors. An ice bag may be applied to the gland and precordium. Plenty of easily digested food, tepid baths and alkaline drinks are equally important. Digitalis as a therapeutic splint to an irregular, rapidly beating, dilated and decompensated heart, will sometimes tide over a catastrophe. Blood transfusion is indicated in a low cell count, 30 per cent or lower hemoglobin and general edema, and more especially when the toxemia has been profound enough to produce a severe psychosis. Bromides and ergot have their place in assisting in the control of certain symptoms.



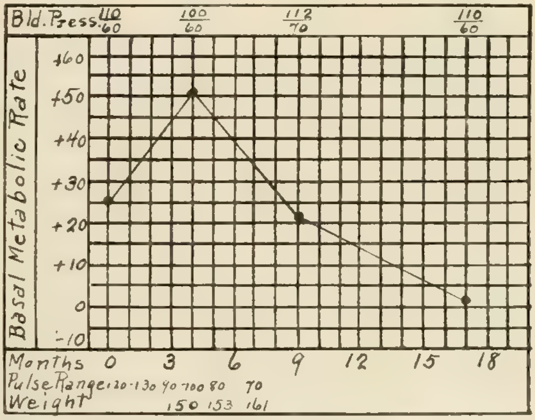
Case 806. August, 1922. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

It was through the efforts of the surgeon that we began to realize the importance of the present conception of the disease. For this reason, therefore, surgical findings in toxic goiter should be held in the highest regard.

Without consideration of the surgical mortality in the most skilled clinics, we must consider this great danger in other centers; also the fear, apprehension, hospitalization and financial cost to the individual, not forgetting the possible return of all symptoms.

Leniency must be used in the criticism of scientific men who, ignoring radium entirely, assert that all treatments have failed except surgery. It must be remembered that prejudice and inexperience will warp the soul of the most sublime.

Radium therapy for toxic goiter as standardized and given to this Society by the author two years ago, at the Boston meeting, merits your serious interest. After seven years of experience with the element, the last three under the most exacting scrutiny by means of laboratory methods and clinical findings, I conclude that toxic goiter can be cured by radium and that it is *not* a surgical disease.



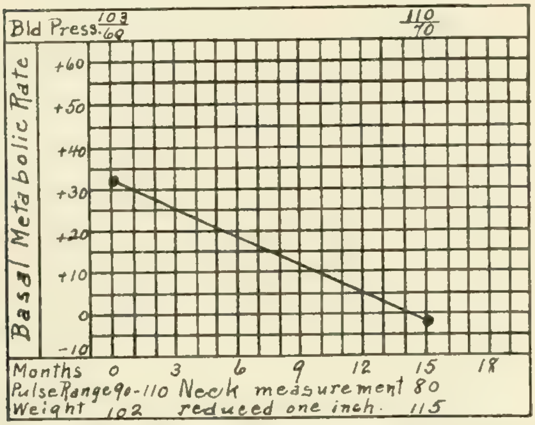
Case 603B. January, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.'

Of the 180 cases I have treated, only 10 were subjected to a second radiation. Four of these had large cystic adenomata and the toxic activity was not completely controlled after the first treatment. The other 6 were given the second treatment with the hope of further reducing the enlarged gland. Three cases, in a state of extremus from myocardial degeneration with general edema, died. One insane patient died from starvation before the treatment had time to benefit the toxemia.

Improvement is noted within the first ten days after treatment, but about the third week all the old symptoms may return, due to the radium reaction. This active stage varies in different individuals. Some express disappointment in not feeling bad, while others are nauseated for a few days.

Within four weeks the nervous tremor has commenced to subside, the appetite has improved and the heart has slowed down twenty or thirty beats. After two months all the symptoms are much better and most individuals gain a few pounds in weight. The improvement is gradual, as shown by the cases reported when the metabolic rate has been taken every three months after treatment.

Some cases are free from all symptoms after six months, while others with large adenomata of long standing and with extensive myocardial change take twelve to eighteen months to show a normal metabolic rate with a normal heart action.



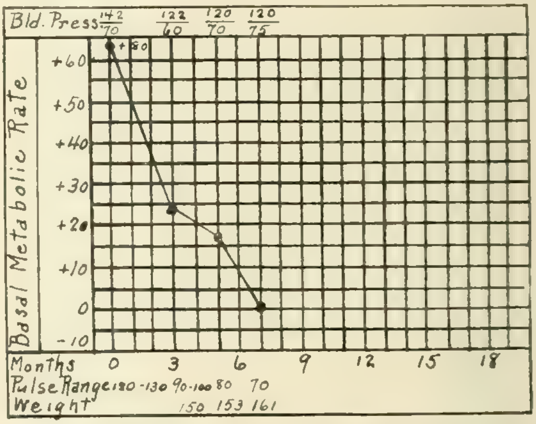
Case 720. October, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

The enlarged gland gradually decreases in size in direct relation to the amount of cystic formation present. All hypertrophy or hyperplasia is reduced to normal while the cystic type is reduced about one-half in size. The exophthalmus in many of my cases has been controlled after three years. However, all do not respond so favorably.

There has been no evidence of myxedema in any of the cases treated. Metabolic readings have been made over a period of two and a half years and all have remained normal.

Many toxic adenoma cases give a history of pregnancy, childbirth or miscarriage initiating the toxic activity. In these young women they run an active and rapid course, so that the symptoms are grave in a very few months. Sixteen of these cases have been treated, and 10 have had second and third pregnancies since treatment without any evidence of thyroid toxemia. Two showed activity at the beginning of lactation but were controlled by means of the ice bag.

Two of our cases had two operations each and 8 had one each for thyroidectomy. Four others had ligation of the thyroid arteries on one side and 2 had both superior thyroid arteries tied off. They had all been benefited for a period of six months to two years, but the remaining portion of the gland had hypertrophied and soon became active. On account of parathyroid glands, discretion in the technique of treatment of postoperative cases must be used.



Case 604. February, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

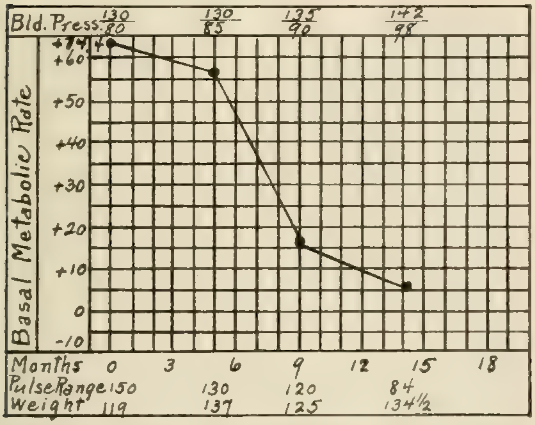
None of my cases have shown any symptoms of parathyroid dysfunction after treatment.

For the last two years all cases with infected tonsils associated with a toxic thyroid have received treatment over the tonsil area conjointly with that of the thyroid gland. One case had a gall-bladder drainage and two had operations for chronic appendix six months after the thyroid treatment.

Abdominal support is given all cases that show visceroptosis by roentgenography. It has been shown experimentally that stimulation of the cervical sympathetic nerves in animals produces exophthalmic goiter, and that thyroid secretions lower the threshold to sympathetic stimulation, so that a vicious circle is established.

It is a question whether radium therapy breaks the vicious circle by diminished gland secretion, thus restoring the balance by some specific effect of the rays on thyroxin itself, or whether radium acts mechanically by blocking the blood supply.

The rapid control of the toxic symptoms after treatment would support the hypothesis of a change in the character of the secretion. Diminished secretion due to cellular change would come later, while thrombosis of the smaller arterioles and capillaries would come last of all.



Case 741. January, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

Corroboration of the objective and subjective symptoms by laboratory standards will verify the findings and establish the diagnosis. The basal metabolic rate in thyroid toxicity proves more than clinical findings, as it registers the degree of severity as shown by the variation in records. A +60 case indicates greater activity, toxicity and severity than one of +20. This known difference in rate is a helpful factor in the prognosis of the case.

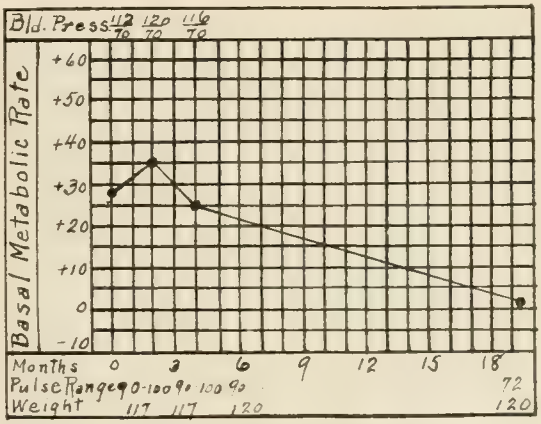
I wish to present here the comprehensive and forceful opinion of C. F. McClintic, M.D., Professor of Anatomy, Detroit College of Medicine, explaining many of the anatomical changes and physiological dystrophies of the thyroid toxemia.

SIGNS AND SYMPTOMS IN EXOPHTHALMIC GOITER

It certainly must be more than a mere coincidence that the signs in exophthalmos so closely approximate the phenomena which result from the experimental stimulation of the inferior sympathetic cervical ganglia. These signs have been produced in dogs and have also been observed singly or in combination in man when these ganglia were stimulated or irritated.

Let us notice, therefore, the anatomical and physiological mechanisms associated with these ganglia and their accompanying phenomena.

1. There is a sheet of involuntary muscle in the upper lid which is supplied by filaments from the cervical ganglia. When this muscle (Mueller's) is stimulated to contraction the upper lid becomes narrowed, the lid rises above the upper margin of the cornea and exposes the white sclera and results in a widening of the palpebral fissure. This accounts for the signs of Graefe and Stellwag.



Case 611. February, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

2. Stretched across the sphenoidal fissure in the apex of the orbital cavity is a sheet of involuntary muscle, the orbicularis muscle, which is supplied by sympathetic nerves from the above ganglia. When this muscle contracts it pushes forward the contents of Tenon's capsule and thereby causes protrusion of the eyeball, or exophthalmos.

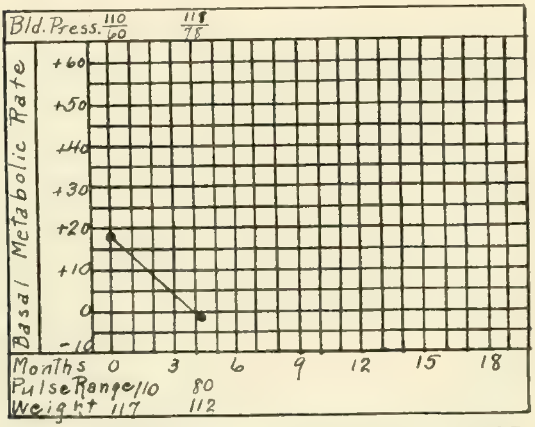
3. In the orbicularis oculi and musculature of the forehead are strands of involuntary muscle which, when stimulated, prevent wrinkling of the skin of the forehead. This musculature is supplied by the sympathetic ganglia of the neck. This mechanism explains Joffroy's sign.

4. (*a*) From these ganglia arise the accelerator nerves to the heart; their stimulation therefore increases the force and rate of the heart tachycardia, and thus raises the blood-pressure.

(*b*) The disturbance of the heart and vasomotor centers assists in explaining the gastro-intestinal and toxic symptoms.

5. The sympathetic nerve when stimulated increases the capacity of the respiratory tree, and the chest remains full (therefore expansion is more limited). This increase in lung capacity with the circulatory changes will explain the findings in basal metabolism.

6. The vasomotor nerves to the head, face, neck and upper limbs arise from these ganglia and thereby account for sweating and other vasomotor phenomena. It has been demonstrated experimentally, that these areas are intimately connected with those of the lower extremity.



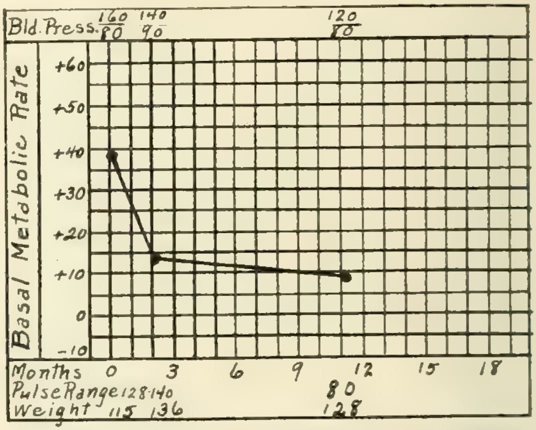
Case 833. October, 1922. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

7. The tremor and rhythm are the same as those for smooth muscle. Langley has shown that all voluntary muscle is supplied by the sympathetic. This will explain how the irritation of these ganglia will account for the tremor. It also explains the sign of Moebius.

8. The bruit associated with exophthalmos and enlarged thyroid is accounted for by the relations of the gland to the common carotid artery. The enlarged gland presses upon and constricts the lumen of the vessel. The blood rushing through the narrowed lumen into the larger portion produces the bruit.

9. The pulsation of the gland may be due to increase in the flow of blood through the inferior thyroid arteries since the gland acts as a shunt to prevent too much blood reaching the brain. It is interesting to note in this connection that filaments of the sympathetic encircle the inferior thyroid artery. When, for any reason, the diameter of the artery becomes increased it tugs upon the nerve and thereby irritates the ganglion, the irritation stimulates the ganglion, it in turn stimulates the heart to force more blood through the artery, this again increases the tugging on the ganglion, etc., thus initiating a vicious circle which can produce all the signs of the condition. May this not account for Osler's cases which occurred from fright and soon passed off?

10. Changes in the gland may occur as a result of the disturbance of its nutritional mechanism. The disturbances or irritation of the ganglia may result from (*a*) pressure due to enlargement of the thyroid gland, (*b*) increase in the diameter of the inferior thyroid artery, (*c*) from infections in the neck or pharyngeal regions, (*d*) due to toxins showing affinity for the thyroid circulation. (Wm. J. Mayo has called attention to the specificity of certain circulatory areas for certain strains of bacteria.) (*e*) General disturbances of the sympathetic nervous system from toxins, faulty diet, emotional states, etc.



Case 687. July, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

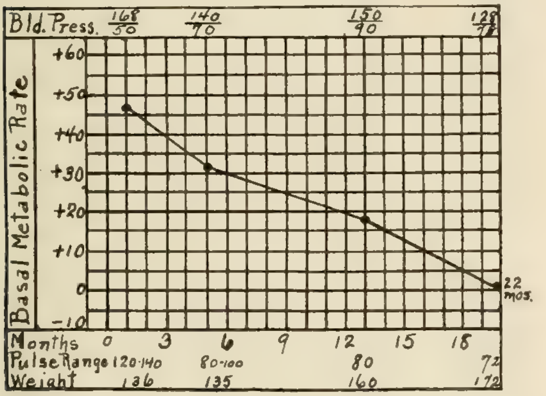
11. Fitting in with these facts is the adrenalin test for exophthalmic goiter. It is to be expected that the administration of adrenalin will aggravate all of the above-mentioned phenomena.

The writer merely mentions these facts as a possible explanation for the signs in exophthalmic goiter based on the functional mechanism associated with the cervical sympathetic ganglia.

RADIUM TREATMENT

At least 100 mgm. of element are used (more often I use 130) in four tubes, each tube being screened in one mm. of brass and 1 mm. of gum rubber. To obtain distance, the screened tubes are placed 1 cm. apart on a gauze pad 2 cm. in thickness.

The gauze pad is made with a loop of adhesive tape at each end so that it can be adapted and tied over an unevem surface without strapping. The radium pad is placed over one lobe for eight or ten hours and then over the other for an equal time, depending on the size of the lobe and the amount of radium used. If the isthmus is enlarged the pad can be arranged to cover one side of it at each application without overlapping and endangering the trachea.



Case 599. January, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

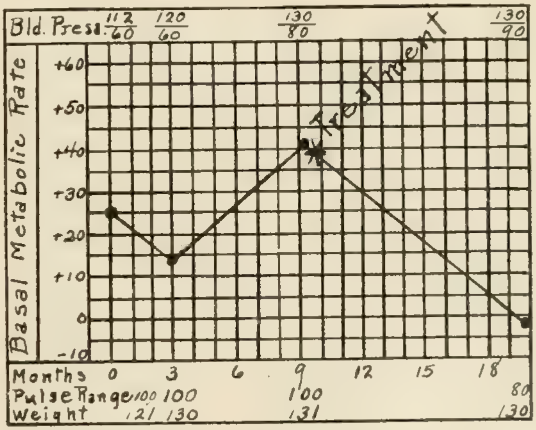
This technique in treatment will give an active hyperemia in the blonde type of individual. The susceptibility of some people (especially if there is a vasomotor disturbance like sweating) has to be considered; so that judgment must always be used at all times.

It is well to advise the use of the ice bag in hourly periods each day, over the gland, for a few weeks following the treatment. This insures rest and controls circulatory and cellular activity. As mentioned before, subsidiary treatment is important after radiation to control arising symptoms of insomnia, tachycardia, indigestion, diarrhea, etc., until the therapeutic effect of the radium has been established.

Case 726. Jan. 29, 1921. Female, aged thirty-one years; married; mother of one child eight years of age.

Family History. Negative.

Past History. Had measles and smallpox when a child. Menstruated at thirteen years; always regular. Had a left brachial cyst removed when seventeen, also had tonsillectomy. Had an ovarian cyst removed five years ago. For the last two years she has had "throat trouble." Had difficulty in breathing and, when going up stairs, tracheal pressure. Severe headaches; fatigue and disinclination to work. Perspires freely and at times has one or two degrees of fever. Appetite good; bowels regular; no insomnia. Has had some middle-ear disturbance from Eustachian infection.



Case 726. January, 1921. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

Examination. No eye manifestations. Fragments of lymphoid tissue within the pillars of both tonsils so that the posterior pillars are adherent to the pharyngeal walls and show evidence of infection. The thyroid gland is enlarged; not cystic, but soft, and causing a compression of the trachea. The left lobe extends beyond the sternomastoid muscle and adjoins the brachial cyst keloid scar. The right is also enlarged but lies well behind the muscle. The area of heart dulness is normal in outline and no murmurs are detected. Pulse rate 110; blood-pressure: systolic 130, diastolic 80. Metabolic rate plus

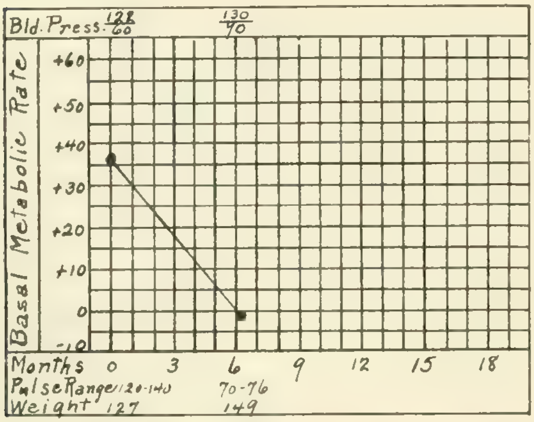
24.1. Upper circumference of neck 13¾; middle 14¼; lower 14¾ in. There is a tremor of fingers on extension; nails have longitudinal striae.

Diagnosis. Toxic adenoma.

Treatment. Local treatment for throat; rest; ice bag to neck with quinine hydrobromid medication.

April 23, 1921. Throat much better, with some improvement in general symptoms. Metabolic rate today plus 13.5.

Oct. 7, 1921. Improvement was only temporary, so that now all the symptoms are exaggerated. Headaches worse; tachycardia; pulse 120; some diarrhea. Metabolic rate plus 40.4. Recommended radium treatment.



Case 810. August, 1922. Comparison of B.P., B.M.R., pulse range and weight in months after radium treatment.

Nov. 2, 1921. One hundred mgm. radium element were used with previously described technique over each lobe of the thyroid for ten hours, and 40 mgm. in the same screening held behind the jaw over each tonsil area for ten hours.

The patient made a satisfactory recovery with complete alleviation of all symptoms. She moved to another city so that I was unable to follow the course of the improvement.

Dec. 7, 1922. After fourteen months of complete relief from all the old symptoms the scar on the side of the neck has softened down and both lobes of the thyroid are apparently normal in size. The lymphoid tissue at the site of the right tonsil has disappeared and the left is healthy in appearance. Pulse rate 80; full and regular. Systolic blood pressure 122; diastolic 80; metabolic rate minus 2.1.

Case 810. Aug. 11, 1922. Male, aged thirty-nine years; married; brakeman. Complained of shaking of the hands, legs and body and of fatigue.

Family History. Negative.

Past History. When thirty years of age he had a renal colic and passed a calculus. Two years ago he was in a railroad accident and had his left clavicle and three ribs broken, also both shoulders injured. He was laid up for five weeks and was very nervous for three months following. About a year ago he had influenza.

Present Illness. Three months ago he became shaky in the limbs, weak, tired easily, was nervous, had insomnia and would wake after sleep with a feeling of fulness in his head. Would almost faint at times from weakness and palpitation.

Examination. Right eye slightly larger than the left. No other eye symptoms. Tongue tremulous. Both tonsils enlarged and chronically infected. Tonsil crypts were filled with necrotic material. Throat and soft palate injected from smoking. Teeth in good condition. Neck very slightly enlarged. Left lobe of thyroid larger than right. Isthmus normal. Some pulsation in neck but no bruit heard. Heart dilated with apex in nipple line. Heart sounds rapid, but no murmur detected. Tremor of hands and knees. Nails have longitudinal striae. Radial pulse 100; apex beat 120; systolic blood pressure 122; diastolic 90; metabolic rate, plus 36.1.

Diagnosis. Primary exophthalmic goiter.

Prognosis. Good; should be controled.

Treatment. (1) 60 mgm. radium element in 1 mm. brass and 1 mm. rubber and 1½ cm. gauze was held beneath right ear over tonsil area for seven hours. (2) 100 mgm. in 1 mm. brass, 1 mm. rubber and 2 cm. gauze in form of a pad was held over left lobe of thyroid for seven hours. (3) The same packages were held over the right tonsil area and thyroid lobe for eight hours.

Sept. 14, 1922. Present weight 133 lbs., or a gain of 6 lbs. since August 11th. Has been feeling fine. Complains of some palpitation and precordial heaving after eating and vigorous exercise. Has had no sore throat or distress of any kind; toxic symptoms lessened greatly.

Examination. Throat and mouth still injected from smoking. Tonsils small with some infection in the left one; neck not enlarged. Heart sounds normal. Pulse and apex beat 100. Systolic blood pressure 130; diastolic 60; metabolism not taken.

Feb. 12, 1923. The patient was treated six months ago. Has never felt better in his life; complains of rapidity of heart action on exertion only. Examination showed the eyes normal; color good; neck still small with no evidence of enlargement or local effect of treatment. No tremor; all symptoms controled. Present weight 149 lbs., or a total gain of 22 lbs. Pulse rate 74; systolic blood-pressure 130; diastolic 70. Metabolic rate minus 3.9.

CASE 805. July 13, 1922. Female, aged thirty-nine years; married; housewife. Complained of choking sensation and general weakness.

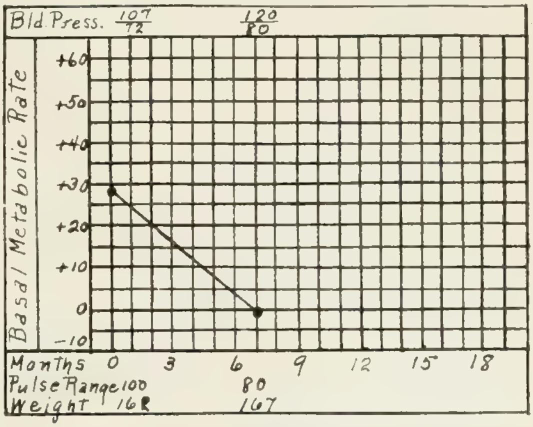
Family History. Negative, except that her mother had goiter.

Past History. Had children's diseases. Always been more or less anemic. At the age of six years the thyroid gland enlarged but became smaller after puberty. Gave no evidence of activity until after the birth of her first child. When lactation ceased the activity subsided until after her second child was born. The activity persisted this time and she was compelled to have a complete left, and a partial right, lobectomy performed three years ago. All symptoms subsided and she remained well for over a year. The gland commenced to enlarge gradually but without any symptoms until about a month ago when she had an acute attack of tonsillitis.

Present History. The patient finds it difficult to breathe at night when lying down, so has been compelled to sleep in a sitting position for nearly three weeks. Has a choking sensation in stooping over or on exertion. Is weak, fatigues easily and is disinclined to work.

Examination. Left eye full and more staring than the right. Right eye also prominent but shows less sclera than the left. Both tonsils enlarged, injected and appear infected. The tongue is tremulous. The neck shows a circular scar down near the clavicle with a bulging prominent right lobe of the thyroid, and an enlarged cystic isthmus. The mass as a whole forces the trachea toward the left and holds it backward, accounting for the choking sensation with increased blood pressure in the head. Upper circumference of the neck is 15 in., middle 15½, lower 16. Heart sounds normal; no murmurs detected. Apex beat and pulse registering 90; systolic blood pressure 107; diastolic 72; hemoglobin 65 per cent; metabolic rate plus 29.0. Some tremor of the hands and fingers.

Diagnosis. Toxic adenoma, recurring as a result of acute tonsillar infection.



CASE 805. July, 1922. Comparison of B.P., B.M.R. pulse range and weight in months after radium treatment.

Treatment. Ninety mgm. radium element in four tubes screened as before, made into a pad 2 cm. in thickness and held over the right lobe and isthmus for twelve hours. Eighty mgm. in two packages of 40 mgm. each with same screening was held below the ear and behind the jaw over the tonsil areas on each side for ten hours.

Feb. 3, 1923. It has been nearly six months since the treatment. The patient reports that within a month she began to improve and that now she feels well; has no nervous symptoms, choking spells or other discomfort.

Examination. Patient looks much better. Right eye still full; right tonsil small; left red and injected. Right lobe and isthmus smaller and measurements show a decrease of 1 in. in each of the two upper circumferences, and $1\frac{1}{2}$ in the lower. Gland soft, and very little tension in the cystic isthmus. The pulse rate is 78; systolic blood pressure 112; diastolic 80; hemoglobin 85 per cent; metabolic rate minus 2.2. The patient has gained $3\frac{1}{2}$ lbs. in weight.

May 16, 1923. At the present time there is no evidence of thyroid toxicity except the fulness of one eye; and the patient reports feeling very well with none of her old symptoms present.

CONCLUSIONS

1. A high systolic and a low diastolic blood pressure show a normally balanced pulse pressure in some cases before the metabolic rate becomes normal.
2. Three months after treatment the metabolic rate was found to be normal in many cases that had been active.
3. A high systolic blood pressure in the late stages of a toxic adenoma is conclusive evidence of myocardial or renal degeneration whenever it is not reduced 20 or 30 per cent after the normal metabolic rate has been re-established.
4. The basal metabolic rate proves and estimates the degree of thyroid activity and also furnishes conclusive evidence of toxic control after radium therapy.

CERTAIN BIOLOGICAL PRINCIPLES OF RADIATION THERAPY*

BY SANFORD WITHERS, M.D.

DENVER, COLORADO

TIME is all too short to give the résumé of this subject that had been contemplated. We shall, therefore, be content to present certain important fundamental principles of radiation therapy, divided for logical discussion into three chapters, depending upon whether the phenomena bear upon the physical, histological or clinical aspects of the cases treated.

This will necessitate making broad statements, to which possible exception may be taken, but will in general present the working ideas that we hold in the treatment of neoplastic conditions by gamma and *x*-rays.

I. PHYSICAL PHENOMENA CONTROLLING THE REACTION TO RADIATION

Let us consider briefly what happens when a beam of gamma or *x*-rays passes through any material substance. We know that the greater the density of the screen the more radiation there is absorbed; and it has been proved that the greater the amount of radiation stopped or scattered the more intense is the local ionization yielded through the production of negative electrons secondary beta particles (the so-called delta rays). These are in every way comparable to soft beta radiation.

The stimulus afforded by the various types of radiation may be detrimental or beneficial to biologic function, the outcome depending largely upon the dosage, that is, the duration of exposure. For example, a certain radiation acting for a brief time on sugar cane may not only facilitate growth but also produce an increase in the sugar content of the stalk of cane (Burns[1]). If, however, this optimum amount of radiation is overstepped, the plant being submitted to a longer exposure or to a greater concentration of rays, there is produced depression, culminating in complete arrest of physiologic function.

The profound retrogressive changes produced by rays of radium on tissue cells are well known. The explanation for this phase of the reaction has been varied. Some investigators have reached the conclusion that the growth-promoting factors in cells can be inactivated by exposure to radiation; and the therapeutic usefulness of radium in checking the cell growth may be ascribed to such a destructive reaction. This factor, the retardation of cell multiplication, has been proved to be transmitted as a mendelian character; not only from cell to cell (Wood and Prime[2]) but from parent to the offspring in mammals (Bagg[3]).

---

* Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

According to other observations, however, the growth retardation may be due to the increase in the permeability of the cells by the injury done to the cell walls through ionization. If treatment is continued, the cells cytolyze completely (Packard[4]). From this it follows that when cells are already highly permeable, as they are during growth and division, complete cytolysis quickly ensues; whereas, when the cell membrane is relatively impermeable, as in the resting condition, radiation must be long continued before destructive cytolysis can be observed. In this connection it will be apparent that those cells in particular which contain electrolytes and substances of high atomic weight will show a greater degree of radiosensitiveness.

It is, therefore, probable that the direct effect of the incident beam of gamma or *x*-rays is practically *nil* and that the biological effect depends almost, if not entirely, upon the amount of ionization produced within the tissues, which, as we have seen, is a function of the absorption and scattering coefficients.

We do not mean to state that the secondary beta particles will all produce the same biological effect; in fact we are, from theoretical considerations, opposed to this view, for it seems evident that the speed of the delta particles (and hence the energy and ionizing power) must vary through certain limits with the amplitude of the incident primary beam (Proust[5]).

II. STRUCTURAL CHARACTERISTICS (HISTOLOGICAL) WHICH DETERMINE THE REACTION TO RADIATION

Regardless of their future as therapeutic agents the use of radium and *x*-rays has demonstrated certain hitherto unknown cellular characteristics (Ewing[6]).

It was observed that certain tissues were *resistant* to even large doses of radiation while others were quite *susceptible* and underwent resolution or retrogression with remarkably small units of beta, gamma or *x*-rays. In general, there are six structural characters which determine susceptibility to radiation. All are of a cellular nature (Withers[7]):

(*a*) It has been shown that the more embryonal or undifferentiated the type of cell the greater is its radio-susceptibility; and conversely the more differentiated, highly specialized the type of cell the greater is its radio-resistance, in general (law of Bergonie and Tribondeau).

(*b*) It is easily demonstrated that cells in the process of dividing (mitosis) are from eight to fifteen times more vulnerable to radiation than when in the resting condition (Mottram[8]). The radio-sensibility too, is a property of the nucleus and is inherent in certain states or temporary physiological periods of cell life, the most important and best known of which is the state of reproduction (Regaud[9]).

(*c*) It is equally true that cells containing large amounts of chromatin material are more easily killed than those containing little chromatin. In other words, cells having hyperchromatic nuclei are in general much more radio-sensitive than similar cells having small amounts of chromatin in the nucleus.

(*d*) It is common knowledge that the endothelium of blood and lymph vessels is very radio-sensitive and that tumors having an abundance of thin-walled, delicate capillaries react much more quickly and favorably to radiation than corresponding tumors having a scanty blood supply.

(*e*) Tumors having small amounts of intercellular connective tissue react much more quickly and favorably to radiation than new growths having an abundant stroma.

(*f*) A period of heightened sensibility corresponds to the maximum metabolic activity of the nucleus in cells which have a secretory function (Regaud[9]). In general it may be said that cells which secrete crystalloid or crystallizable material are much more radio-sensitive than non-secreting cells having the same histological characteristics, or cells that secrete colloid or protein substances.

It was the presence of these histological characteristics, wholly or in part, in tumors which responded quickly to radiation, that led certain authors to assert that radium was selective in its action for certain types of cells.

The effect on the cell is shown by every degree of change from stimulation to death. The dead cells are removed by autolysis and phagocytosis, but the connective tissue substances are resistant and they are absorbed slowly. Arguing from these premises Regaud asserts that gamma and *x*-rays of very short wave-length are "elective-poisons" for nuclear chromatin, upon which, as is known, heredity depends. Hence the rays suppress or suspend cellular reproduction in a tissue.

On the other hand, tissues prove relatively insusceptible to radiation when the cells are differentiated, adult in structure and contain small amounts of chromatin in the nucleus; when they grow slowly and mitoses are few; when the blood supply is through well-formed, adult vessels and when there is much intercellular material or stroma (Ewing[6]).

Again, the presence or absence of any one of these characteristics to a marked degree enables one to predict on *a priori* grounds that the growth *will* or *will not* retrogress favorably under radiation properly applied. The radio-sensibility of cells does not in anyway depend upon the anatomical location, but entirely upon the histological picture presented.

For example a lymphoid hyperplasia which is made up of hyperchromatic and undifferentiated cells is almost as vulnerable to radiation as sex cells and will undergo retrogression with mild radiation whether it be a lymphosarcoma, a Hodgkin's gland, an hypertrophied Peyer's patch, a thymic or tonsillar hypertrophy or a tuberculous cervical adenitis.

III. CLINICAL CONDITIONS WHICH INFLUENCE THE REACTION TO RADIATION

The clinical conditions which influence the reaction to radiation may be divided into two groups: those purely local in their manifestations and those of a constitutional nature.

1. Local Conditions Which Influence the Reaction to Radiation. (*a*) One of the most important reactions following the irradiation of a localized area is the intense infiltration of cells and serum which accompanies the inflammatory reaction. The presence of this zone of lymphocytes and plasma cells constitutes the first barrier to the neoplastic invasion, just as the leucocytic infiltration about a pyogenic infection walls it off. It has been very well proved by Broders[10] and others that the presence of a round-cell infiltration in the zone of proliferation of an uninfected malignancy argues that such a growth is relatively less malignant than one having a similar cell structure, but without the intense round-cell infiltration. In other words, the presence of a round-cell infiltration about a malignancy, whether it occurs as a part of the natural body resistance, or is stimulated by radiation, is one of the first steps in causing the retrogression of neoplastic elements.

(*b*) The study of the vascular connective tissue of the stroma has furnished us with data which deserves to be emphasized. In the biopsies practiced before treatment, the characteristics observed almost always in patients in whom a favorable outcome of the course of treatment can be expected (Laborde[13]) are as follows: A connective tissue stroma of normal appearance with a minimum of acute inflammatory reaction, a collagen woof taking a normal stain, the presence of capillaries, of which the walls appear well formed, the occurrence of perivascular infiltration of round cells and polynuclear eosinophiles.

On the contrary, the aspects which have appeared unfavorable to us, from the point of view of the local reaction upon the stroma of the tumor, as well as that of the resistance of the stroma to radiation, are a dissociated connective tissue, whose fibrils have more or less lost their affinity for stain, or vessels, the walls of which appear altered, and an infiltration of the polynuclear neutrophile type only.

As a result of these researches, it is evident that the condition of the vascular and connective tissue stroma deserves further study, not only in the course of treatment by radium, as has been done by most writers up to the present, but also and particularly *before* treatment. The perivascular alterations which we have observed in some cases before a therapeutic treatment prove that there is an undeniable interaction of neoplasm on the stroma and explain to us why, in certain cases, the alterations of vascular and connective tissues are much more pronounced in the course of some treatments than in others.

(*c*) The repair of irradiated tissue following the radiation reaction is brought about through the deposit of white fibrous connective tissue in interlacing lamellae throughout the area radiated. This scar tissue formation is similar to the repair that takes place in other traumatized areas, and is a function of the absorbed radiation and largely due to the secondary beta particles, as before mentioned.

(*d*) Accompanying the irradiation is produced a local obliterative endarteritis, which in many sections has the appearance of marked arteriosclerosis. This closing of the blood-vessels and lymph spaces through the combined action of the arteritis, perivascular round-cell infiltration and scar tissue formation, effectively incarcerates persistent neoplastic elements.

(*e*) Regaud[9] points out that when an area is subjected to repeated doses, the same normal cells are irradiated, but not the same malignant cells. Hence the integuments and connective tissue elements become successively *less* radio-resistant through the cumulative changes which have made the malignant cells become *more* radio-resistant. And in those cases where a cure, and not palliation alone, is sought, an attempt should be made to give the entire dose at a single sitting, to avoid the necessity of giving a second or third dose of greater intensity with the consequent greater damage to normal elements.

2. *Constitutional Conditions Which Influence the Radiation Reaction.* These conditions can be summed up by saying that any condition which affects the body as a whole must necessarily affect every cell in it. Please understand then, that when dealing with malignancies it is necessary to have the physical functions of the body as nearly normal as possible. The presence of a marked cachexia with the usual anemia and leucopenia should make the prognosis guarded even though the malignancy is well localized and one which would ordinarily be termed favorable. This is likewise true in the case of diabetics or luetics and those having marked cardiovascular or cardio-respiratory diseases. The presence, then, of any marked constitutional disability seems to render the normal tissue more radio-susceptible and the repair following irradiation prolonged in the extreme. Without wishing to be dogmatic there is some reason for believing that patients showing little lymphocytic fall in the circulating blood upon irradiation react better to the treatment than those in which a marked fall occurs (Lazarus-Barlow[11]).

On the other hand, constitutionally important phenomena are known; in particular, the modifications of the blood which follow the treatment of cancer by penetrating rays. According to Seitz and Wintz, the alterations of the blood are constant and characterized by an abundant destruction of the formed elements. In general, it takes from six to eight weeks for the blood to return to the condition which existed before irradiation. Certain patients cannot regenerate their blood-cells, and when the sanguinary alterations continue, they die, the strong doses of ray seeming to have hastened their death.

In addition there are certain changes produced in the organism which are the direct result of the irradiation upon neoplastic cells. We refer to the production of substances formed under the influence of the irradiation which may act in the manner of antibodies. Contamin has shown that the inoculation of mouse or rat tumors feebly irradiated produces an immunity against additional grafts of the neoplastic tissues. It is necessary here that the irradiation should be just sufficient to produce an inhibition of the neoplastic elements, because if the dose is too large, inoculation of the irradiated tumor is no longer capable of conferring immunity. These experiments have been repeated quite recently by H. Charles, G. Scott and Sidney Russ[12] and have confirmed the possibility of conveying immunity by neoplastic grafts. It seems true that immunity cannot be produced by inoculation of cells which are still living. On the other hand, it is well proven that the indirect action on the cancer through antibody formation is insufficient to inhibit its growth, and the actual state of our knowledge at present is that we do not know how to provoke this reaction. According to those who are best informed, we can count only on the local action of the rays. It is therefore essential that all the neoplastic cells of a tumor receive sufficient doses of rays to bring about their destruction, because not only can the incompletely irradiated elements become a point of growth departure for a recidive, but weak doses are likely to provoke a stimulating reaction. With these conditions it is advisable that proper measures be taken to promote body welfare, and that irradiation be undertaken with a great deal of thought and preparation so as not to hurry such patients to their death by over-irradiation.

In the practical treatment of malignancies with radium or *x*-ray there are four chief points to be kept in mind which necessitate the very closest cooperation of the surgeon, pathologist and radiation therapist:

1. The pathology must be interpreted into terms of radio-sensitiveness.
2. The proper area or areas for irradiation must be accurately determined.
3. The required dose of radiation must be placed in that part of the growth where the active proliferation is taking place to stimulate normal tissue resistance to the invading neoplasia and obliterate the blood-vessels and lymph spaces.
4. The normal tissues must be protected in every way possible so as not to break down the natural body resistance through the destruction of continuity of normal tissue stroma, intra- and peri-tumoral cellular infiltration, and the formed elements of the blood, which make up the triumvirate of tissue defenders. These must be conserved and stimulated.

Reactions to radiation are not only qualitative but quantitative, when all the factors involved are taken into consideration; but this statement does not permit of the interpretation that there is, or can ever be established, a standard carcinoma or sarcoma dose, since no two growths have identically the same cell structure or surrounding normal tissue stroma permitting identical reaction.

CONCLUSIONS

1. That the cellular reaction to radiation depends upon the amount of radiant energy absorbed, whether it be primary or secondary in origin.
2. That susceptibility to short wavelength therapy is a cellular characteristic depending upon a definite histological structure.
3. That the normal tissue reaction to radiation and neoplastic invasion depends to a large degree upon the well-being of the body as a whole.
4. That there is sufficient data extant to predicate on *a priori* grounds those tissues or tumors which will prove radio-resistant or radio-susceptible.
5. That the use of radium or *x*-rays is just as radical and rational a procedure as the use of other physical agents in the treatment of neoplastic conditions.
6. That the use of radium or *x*-rays in a given condition should require also an equal amount of surgical judgment, a more complete knowledge of the pathology present and a broader biophysical training than the corresponding surgical treatment demands.

BIBLIOGRAPHY

1. BURNS, D. An Introduction to Biophysics. New York, 1921. p. 126.
2. WOOD FRANCIS CARTER, and PRIME, FREDERICK, JR. The action of radium on transplanted tumors of animals. *Ann. Surg.*, Dec., 1915, lxii, No. 6.
3. BAGG, HALSEY J. Disturbances in mammalian development produced by radium emanation. *Am. J. Anat.*, Jan., 1922, iii, 133.
4. PACKARD, D. The susceptibility of cells to radium radiations. *Proc. Soc. Exper. Biol. and Med.*, 1923, xxi, 226.
5. PROUST, ROBERT. On penetrating radiotherapy by *x*-rays and radium. *Arch. Radiol. and Electroth.*, Sept., 1922, No. 266.
6. EWING, JAMES. Tumors of nerve tissue in relation to treatment by radiation. AM. J. ROENTGENOL., Sept., 1921, viii, 407.
7. WITHERS, SANFORD. Fundamental Principles of Radiation Therapy (in process of publication).

8. MOTTRAM, J. C. *Arch. Middlesex Hosp.*, 12th Cancer Report, 1913.
9. REGAUD, CL. Fondements Rationnels, Indications Techniques et Resultats Generaux de la Radiotherapie des Cancers. *J. de radiol. et d'electrol.*, Apr., 1920, iv, 433.
10. BRODERS, A. C. Squamous-cell epithelioma of the lip. *J. Am. M. Assn.*, 1920, lxxiv, 656.
11. LAZARUS-BARLOW, W. S. A critical review of the cancer problem. *Med. Sci.*, 1920, iii, 108.
12. RUSS, SIDNEY. On the local and generalized action of radium and *x*-rays upon tumor growth. *Arch. Radiol. and Electroth.*, Sept., 1921, No. 254, p. 129.
13. LABORDE, SIMONE. Considerations Súr La Curiethérapie des Cancers. *J. de radiol. et d'electrol.*, Aug., 1922, vi, No. 8.

A STUDY OF THE ACTION OF MEASURED RADIATION DOSES ON CARCINOMATA OF THE UTERINE CERVIX*

BY HENRY SCHMITZ, A.M., M.D., F.A.C.S.

CHICAGO, ILLINOIS

IN the radiation treatment of carcinoma of the uterine cervix, clinical and microscopic examinations are of the utmost value for diagnosis, prognosis and treatment. The effectiveness of the radiation depends on the radiation energy applied, the extent of the disease within the true pelvis, the type of epithelial cell composing the new growth and the constitutional reaction caused by the effects of radiation. We must render the prognosis and determine the method of treatment solely from these findings.

A study of the cervical carcinomata from this viewpoint has been undertaken to ascertain whether the lethal radiation doses for the different types of cells found in these new growths could be determined.

As early as 1904 Exner[1] described the changes caused by radium rays in a breast cancer. He attributed to the connective tissue the greatest importance in the dissolution of the malignant growth. Additional similar investigations were reported by Caan,[2] Finzi,[3] Janeway,[4] Wickham and Degrais,[5] Ewing,[6] Bumm, Doederlein, Weinbrenner,[7] Kelly and Burnam,[8] Kehrer,[9] Lahm[10], Clark, J. G.,[12] Schmitz,[13] Alter[14] and others. Lahm[10] asserted that the changes in the connective tissue are secondary, while those in the cancer cells are of primary importance.

Carcinomata of the uterine cervix are composed of either basal, squamous, or cylindrical epithelial cells. The greater the degree of immaturity, of departure from the adult normal histological type, the greater is the clinical malignancy. The basal cells are spindle-shaped and unripe and have not as yet acquired the differentiated adult form of either the squamous or the cylindrical epithelial cells. Therefore the basal-cell cervical carcinomata are the most malignant. Cervical carcinomata are seen as proliferating, ulcerating or infiltrating growths. Adams and McCrae state that all cases are carcinomatous in which there is infiltration and apparently independent growth of epithelial or gland cells into the surrounding tissue; and this, whether of slightly or markedly atypical cells.

Repeated cervical lacerations disturb the normal structures and functions of this tissue, interfere with its nutrition and expose the weakened structure to chronic irritation and inflammation. A chronic endocervicitis precedes cancer in the great majority of cases—34 out of 48 (Polese). The routine examination of this tissue may reveal abnormalities in the morphology and position of the epithelium which constitute precancerous conditions. The most prominent of these conditions is the cervical erosion, many instances of which show suspicious hypertrophy and heterotopia of the lining epithelium. Beckmann saw the development of carcinoma in an erosion which he had treated for five years (Ewing). Carcinomata do not primarily develop in the scars resulting from the healing of lacerations from the trauma of labor.

The changes produced by radium and *x*-rays in carcinomata concern those seen in the parenchyma and those observed in the stroma. The carcinoma cells undergo degeneration and the connective tissue cells and blood-vessels of the stroma show signs of inflammatory reaction.

---

*Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

The degenerative changes of the cells are chiefly a necrobiosis of the nucleus which leads to a complete breaking up or caryolysis. The ultimate fate of the cell is thus settled.

The inflammatory reaction begins soon after the radiation and consists of an infiltration of the stroma with polymorphonuclear leucocytes, at first without a proliferation of the stroma cells and blood and lymph vessels. Many of the cancer cells are densely surrounded by leucocytes, and one gains the impression that substances are liberated by the disintegration of the cells which exert a pronounced chemotaxis on the leucocytes.

At times, here and there in a section, are seen remnants of carcinoma cells, which impress one as being almost entirely composed of a leucocytic exudate. However, on closer examination blood-vessels with necrotic walls and thrombi are seen; and this contradicts the latter deduction.

The changes seen in the blood-vessels within the tumor consist mainly of thromboses and inflammatory processes in the walls resulting in an obliteration of the lumen and necrosis of the surrounding tissue. Changes in the cells of the connective tissue are not seen in the early stages. However as time passes we observe a rapidly increasing formation of fibroblasts with a corresponding decrease in the number of polymorphonuclear leucocytes. The latter are replaced with lymphocytes and plasma cells. Finally is seen the formation of connective tissue fibers, which gradually increase in numbers. Therewith the changes in the carcinoma tumor are completed.

We do not wish to state whether the changes in the parenchyma or those in the stroma are primary and most important.

In 1917 in a paper read at the annual meeting of the American Radium Society we called attention to the difference in the changes produced by radium in the different types of carcinoma cells as follows:

The squamous-cell carcinoma of the cervix evinces a papillary arrangement of the cells. Hornification or epithelial pearl formation is often seen. The connective tissue is edematous and loose. The round-cell infiltration in the wall of defense consists of plasma cells, eosinophiles, mast-cells, leucocytes and lymphocytes. It is mostly an everting, rapidly proliferating cancer without simultaneous extension into the tissue.

The changes caused by radiations in the epithelial cells of the epithelioma are cytolysis and caryolysis as granulation and vacuolation of the protoplasma, destruction of the cell wall, loss of staining power of the nucleus, cessation of mitosis and breaking up of the nucleus into amorphous debris. As the disintegration of the carcinoma cells progresses, so the round-cell infiltration and fibroblast formation increase. The round-cell infiltration is especially rich in eosinophiles. The tumor disappears by the action of phagocytes.

The unripe basal-cell carcinoma of the cervix shows columnar arrangement of the spindle-shaped cells with very little connective tissue. The growth is mostly infiltrating. The rays cause a necrosis of the central portion of the alveoli characterized by the formation of amorphous masses and cell detritus, while the peripheral cells are the last to succumb. Giant-cell formation is almost always seen. The vacancies in the tumor are rapidly filled by fibroblasts. Necrosis and connective-tissue formation are the characteristic degenerative and reparative processes in this variety of carcinoma.

The cylindrical-cell carcinoma usually shows an adenomatous arrangement of an acinous type. The connective-tissue stroma between the adenomatous masses of cancer cells is more or less prominent. A wall of round cells is usually present. The rays cause a rapid degeneration of the carcinoma cells with a corresponding rapid formation of fibroblasts.

Alter,[14,15] in a valuable study, discusses the histological changes of the different cell types of carcinoma after exposure to radium rays. He investigated the mechanism of the changes separately in each individual type of epithelial cell cancers. By comparison of the change in the parenchyma and the connective tissue of each type he answered the question: Is the connective tissue proliferation or the change in the parenchyma primary? In passing I might state that Alter saw a very marked eosinophilia in most of the microscopic sections examined. The varying clinical response of different types of malignant disease to radium must impress even the most causal observer. These differences appear to be correlated to variations in the histological character of the growth. Both the nucleus and the protoplasm figure conspicuously in the histological changes following exposure to the rays of radium. Both these parts of the cell show different behavior toward the rays in the different types of carcinoma. These differences suggest different absorption of the rays. The physiological action of the rays is proportionate to the absorbed amount, but will also depend upon the kind of process initiated through the transformation of absorbed energy. The protoplasm of the benign and of the different types of malignant cells reacts differently toward the rays. This difference suggests again that different physical-chemical and chemical conditions are responsible for the different absorption of the rays. Some general and very definite morphological changes of the protoplasm suggest chemical interpretation very strongly. The conclusions reached were: Different types of carcinoma show characteristically different behavior toward the rays of radium. The behavior depends mainly on the state of differentiation of the different types of carcinoma. The more undifferentiated and embryonic in type the carcinoma is, the more effective is the action of radium rays upon it. On the differentiated types the rays of radium have a hastening effect. If the effect of these rays is proportional to the absorbed amount, the nuclei and protoplasm of different types of carcinoma and benign tissue absorb different amounts of rays.

Lahm [16] propounded the question: Does a microscopic examination make it possible to prognosticate the primary or secondary cure of a carcinoma at least within certain limits? The answer was “Yes,” and proven as follows:

“If the sensibility of the carcinoma is 60 per cent of a unit skin dose, then the curative action of the rays extends to a radius of 4.8 cm.; if 80 per cent, to 3.8 cm.; if 100 per cent, to 3.5 cm., and if 120 per cent, to 3.2 cm. If we could determine the radio-sensibility of a carcinoma, we could also determine the radiation dose to cause a primary healing, if we consider (1) the bimanual and clinical findings, (2) the radio-sensibility of the carcinoma, and (3) the resorption of the tumor mass, i.e., local healing. The results obtained were that ripe carcinomata require 3000 to 7000 mg. el. hrs.; middle ripe, 4000 to 5000; and unripe, 6000 to 7000; while adenocarcinomata are refractory to any dose.”

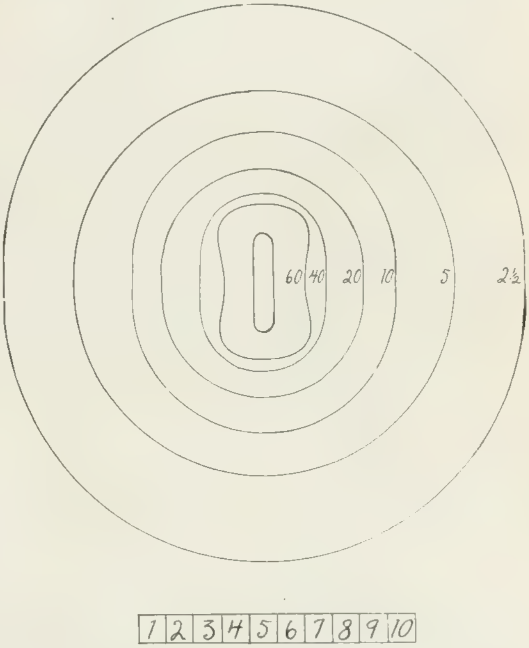


Fig. 1. The equal intensity curves of 50 mg. radium element measured in water.

The changes caused by gamma rays in the carcinomata and revealed by microscopic examination were: (*a*) regular and irregular mitotic nuclei, (*b*) numerous giant-cell formations, (*c*) caryolysis and cytolysis with granulation and vacuolation of the protoplasm, and (*d*) the formation of a zone of reaction around the growth of variable extent composed of plasma cells, lymphocytes, polymorphonuclear neutrophiles and eosinophiles. The eosinophilia is the best evidence of an early and complete resorption of ripe and middle-ripe carcinomata, while the presence of plasma cells and leucocytes indicates an inability of the host to activate the defensive forces necessary for a degeneration of the carcinoma. The occurrence of eosinophilia runs parallel with the progressive healing of the cancer. Of 156 carcinomata treated between the years 1915 and 1918, 36 had eosinophilia and 120 did not. Of the former, 14, or 40 per cent were cured, 19, or 53 per cent died and 3, or 7 per cent could not be traced. Of the latter, 21, or

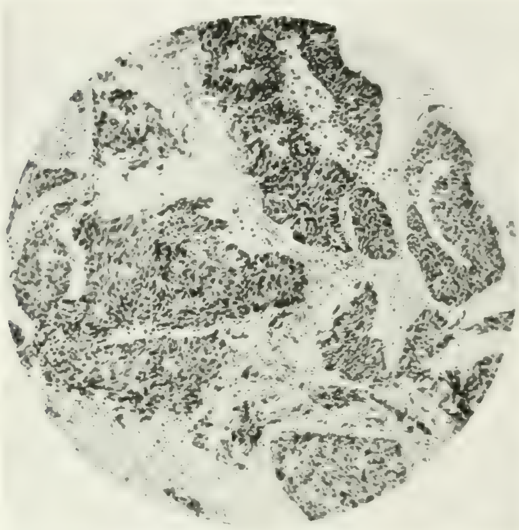


Fig. 2. Unripe basal-celled carcinoma of the uterine cervix before radiation treatment.

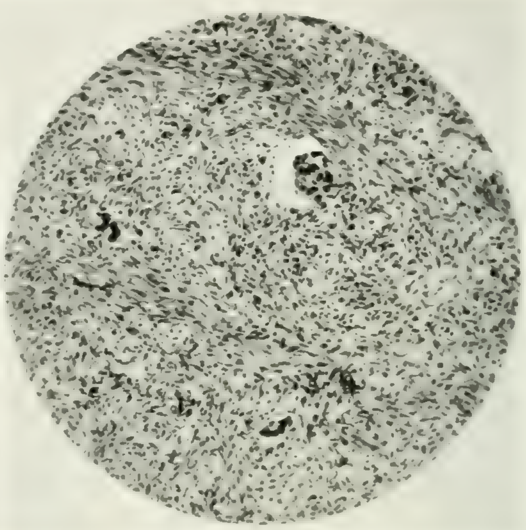


Fig. 3. The histological changes caused within three weeks in the basal-celled cancer seen in Figure 2 with a combined 100 per cent E.S.D. of radium and x-rays.

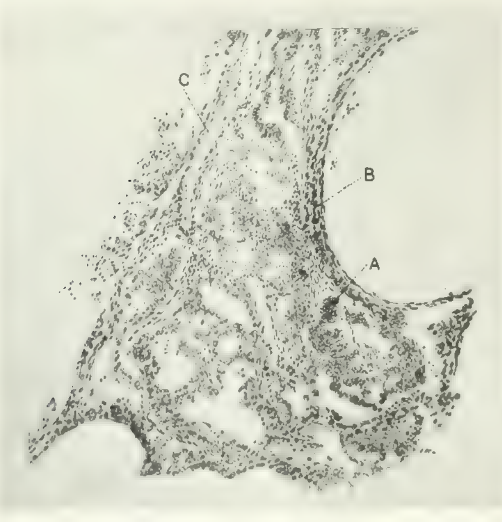


Fig. 4. Adenocarcinoma of the uterine cervix before radiation treatment.

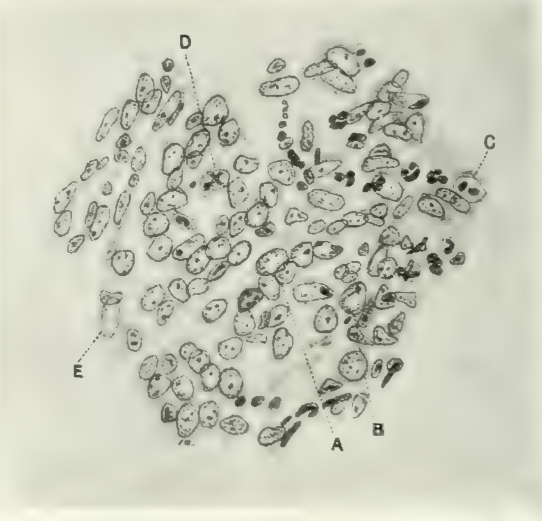


Fig. 5. High-power magnification of an area in Figure 4.

17.5 per cent were cured, 98, or 81.5 per cent died, and 1, or 0.9 per cent could not be traced.

Lahm states that the virility of the carcinoma cell does not depend on the morphology but on the preservation of the colloidal state of the protoplasm. The protoplasm is injured by the rays, hence dissolution of the reticulum, vacuolation of the protoplasm and finally dissolution of nucleus and cell. During this process poisonous or injurious ions accumulate in the periphery of the carcinoma, stimulating the division of the cells and causing the formation of mitoses and of polymorphonuclear cells.

The investigations of Alter, Lahm and myself permit the deductions that the different types of carcinomata react differently to the action of radium rays and that the different behavior enabled Lahm to express this difference within definite limits in a lethal radiation dose for each type of carcinoma cells.

The action of radium is local. The intensity within tissues or tumors depreciates rapidly. A homogeneous penetration of the entire true pelvis with radium rays inserted intracervical is impossible. If a carcinoma possessed a radio-sensibility of 60 per cent of the full skin dose it could be effectually radiated within a radius of 4.8 cm., according to Lahm. The radius of the true bony pelvis which forms the natural limit of a cervical carcinoma still amenable to radiation treatment is 6 cm. Should the regional lymph-nodes be invaded, they would receive too small a dose. Assuming that Lahm's radium dose is expressed in the per cent of the customary 100 per cent erythema skin dose, the 60 per cent dose is an irritating one and tends to stimulate the growth to more rapid proliferation.

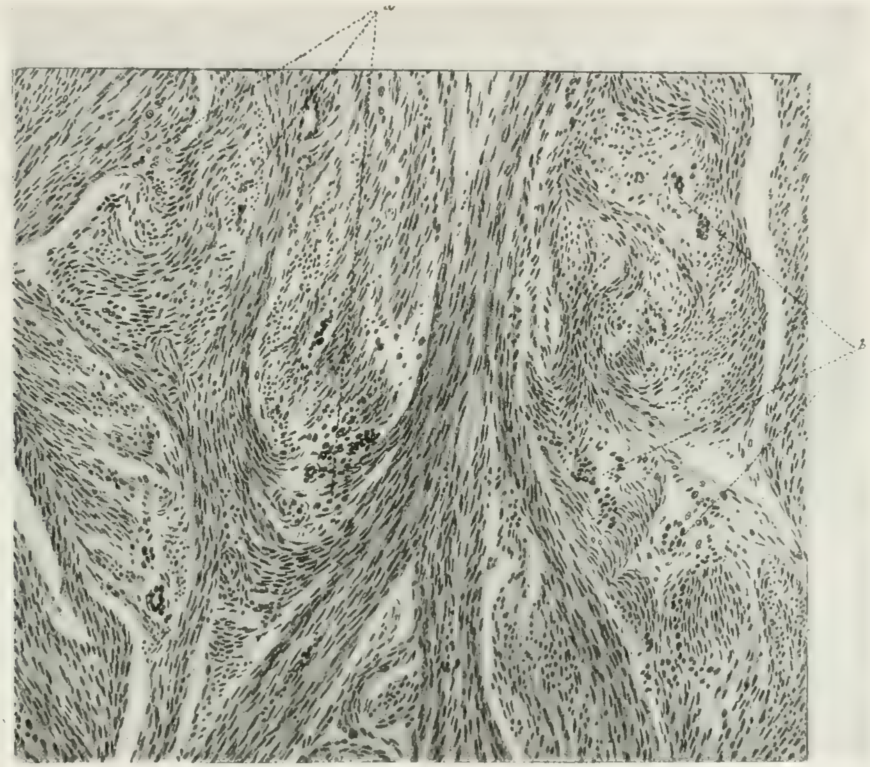


Fig. 6. The uterus was removed two days after a combined radium and x-ray application of about 130 per cent E. S. D. Note the marked fibroblastic infiltration and almost complete disappearance of the carcinoma cells.

We have investigated the distribution of the intensity of gamma rays of radium.[17] The equal intensity curves are shown in Figure 1. The full skin dose, that is, the 100 per cent erythema skin dose, is attained at isodose 60 with 1600 mg. element hours, (mg. el. hrs.,) at isodose 40, with 2400 mg. el. hrs.; at isodose 30, with 3200 mg. el. hrs.; at isodose 20, with 4800 mg. el. hrs.; at isodose 10, with 9600 mg. el. hrs. The median transverse diameter of isodose 60 is about 3 cm., the longitudinal axis 5.5 cm.; at isodose 40, 4.5 and 6.3 cm. respectively; at isodose 20, 7 and 8 cm.; at isodose 10, 9.5 and 10.7 cm. The object of radiation therapy must be to kill the carcinoma without causing irreparable injury to normal tissues and organs lying within the path of the radiation field. The posterior bladder wall is about 2.5 cm., and the anterior rectal wall about 2.5 to 3 cm. distant from the cervical canal. The permissible maximal radiation dose which the rectal and vesical mucosae will endure without permanent injury is about 130 to 150 per cent of the erythema skin dose. As they lie at about isodose 30 the highest permissible gamma ray dose that we may apply is with 130 per cent E. S. D. 4200 mg. el. hrs., and with 150 per cent E. S. D. 4800 mg. el. hrs. Assuming that a carcinoma had a radio-sensibility of 100 per cent and occupied an elliptical area of a median transverse diameter of 7 cm. and a longitudinal axis of 8 cm., the carcinoma dose of 4800 mg. el. hrs. would be lethal. Therefore if we use radium alone we can benefit only a small number of cervical carcinomata. Should the radio-sensibility of the carcinoma be less than 100 per cent and the E. S. D. be 150 to 175 per cent, then the prognosis would be less favorable.

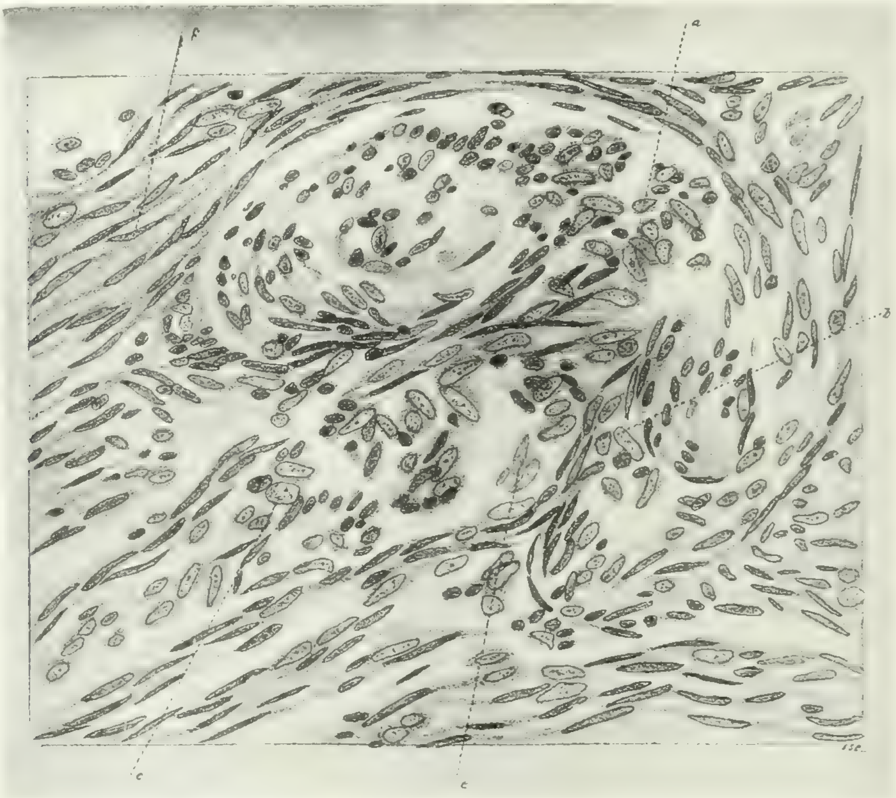


Fig. 7. High-power magnification of an area of Figure 6 to show the degeneration of the nuclei and protoplasm of the cancer cells.

The radiation energy applied must be of the same, or practically the same, intensity at the periphery of the bony pelvic walls as in the center. Such a homogeneity of intensity may be attained either by distributing the radium all through the pelvis or by using a combined application of radium and *x*-rays. Radium may be evenly distributed through the pelvic cavity by the use of needles containing radium salt or glass capillary tubes filled with radium emanation. Instead of glass capillary tubes, those made of a material soluble in body tissues may be used.[18] These methods necessitate a laparotomy. We have discarded the method of "needling," as the poor results did not warrant a continuation.

The combined application of gamma and *x*-rays enables one to devise a method which assures a homogeneity of radiation intensities all through the pelvis. I shall not discuss this method, but refer to the publications on this subject.[19,20]

These investigations placed us in a position to study the changes produced with measured radiation doses in carcinomata of the uterine cervix. They comprised observations on the relation of the measured radiation energy to (1) the chemical constituents and defensive ferments of the blood, (2) the local palpatory evidences of the disease, and (3) the microscopic examinations of tissues.

The application of a lethal dose to carcinomata causes a destruction of the malignant cells, and to some extent, of normal cells, especially the white blood corpuscles. The split proteins are absorbed and a non-specific protein toxicosis ensues, evidenced by an increase in the nitrogen constituents and a decrease in the chlorides of the blood. This is the more remarkable as Theis and Stone[21] found a low content of non-protein nitrogen and urea nitrogen in the blood of carcinoma patients, while Hirsch and Peterson[22] did not find any changes after radiations. The toxicosis, also, changes the total number of the white blood cells and the percentages of the different white cells. These changes correspond to the typical picture seen in anaphylactic shock. A cancer patient refractory to the rays does not show any disturbance of nitrogen metabolism, the white blood cell count or the percentage of the white cells. The absence of these reactions indicates a negative result from the radiation treat-

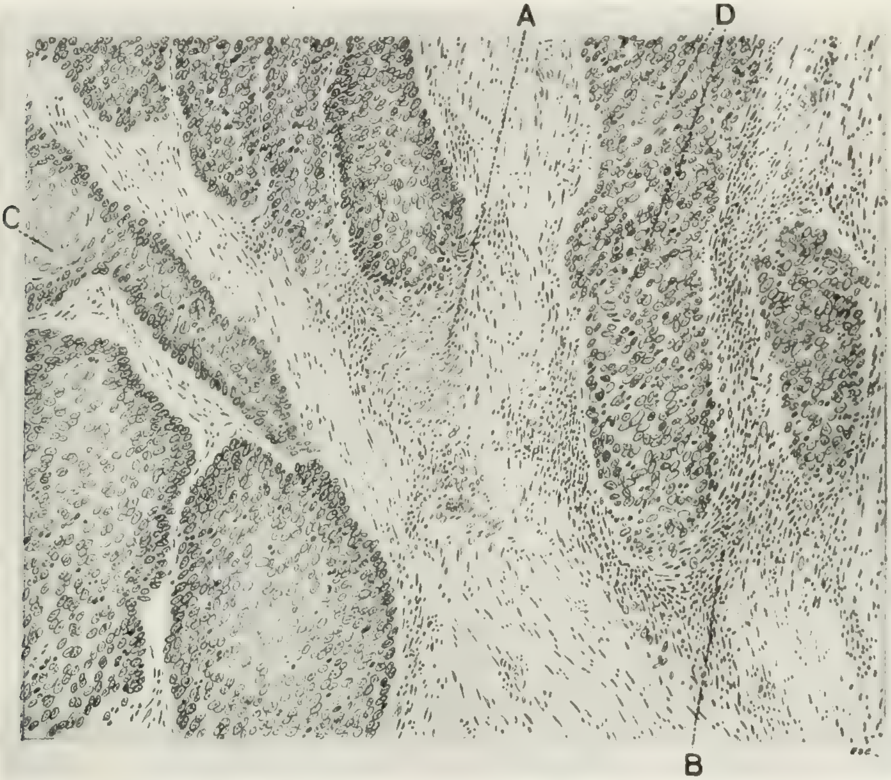


Fig. 8. A squamous epithelial-cell cancer of the uterine cervix before radiation treatment.

ment caused by either a general resistance of the patient (seen especially in advanced cachexia) or an insufficient dose of rays.

The Freund-Kaminer[23] test for carcinomata is based upon the observation that the isolated cells of carcinoma are dissolved by the serum of non-cancerous individuals, whereas this property is wanting in the sera of carcinoma patients. They also showed that if a carcinomatous growth is surgically eradicated, the serum of such patients would reacquire carcinolytic properties. We therefore concluded that if a carcinoma has been completely degenerated by radiations, the blood of such patients should show carcinolytic properties. This assumption was proven to be correct. These investigations will be published in the near future. Whether we shall be able to use the results clinically, or whether they will corroborate the contention that rays can effectually destroy carcinoma, cannot as yet be stated. Herly[24] and Coca[25] studied the diagnostic value of the Freund-Kaminer reaction and they deny it any diagnostic possibilities. However, these conclusions do not interfere with our investigations, as we are testing the relative values in microscopically proven carcinomata.

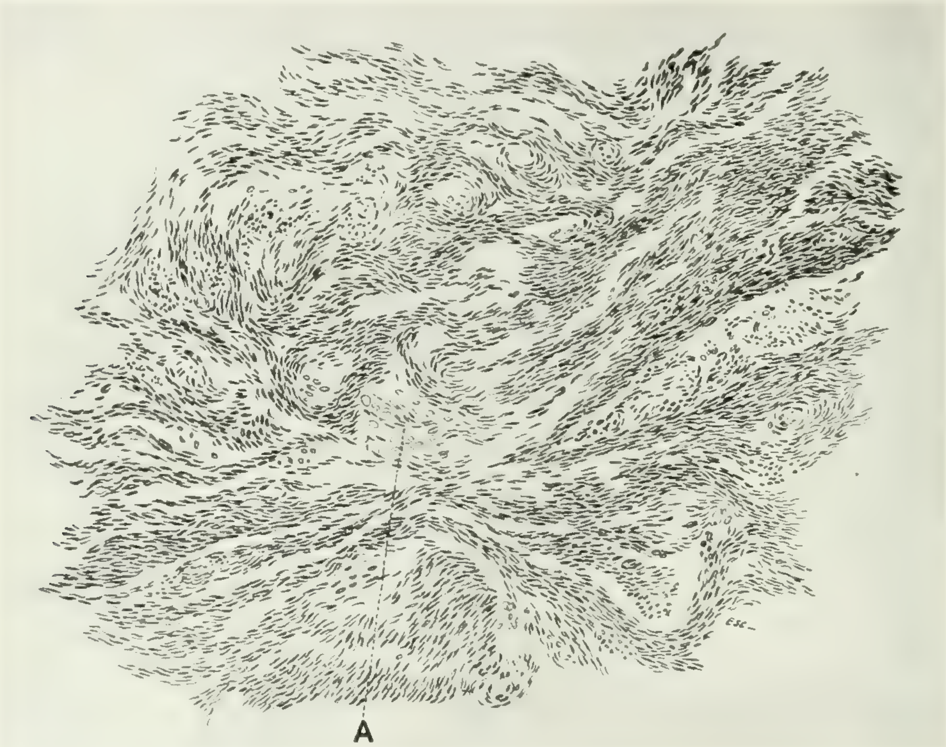


Fig. 9. The uterus was removed three months after the application of about 175 per cent E. S. D. of radium and x-rays. Note the connective-tissue formation and the practically fatal absence of malignant cells.

A lethal carcinoma dose should be followed by negative palpatory findings. The cervix should be healed and the parametria free of any induration. The pelvic organs should become movable and of normal consistency, though scar formation may leave indurated bands behind. The microscopic examination of excised tissue from such a "healed" cervix must reveal total absence of epithelial cancer cells. These two conditions are the criterion upon which we must base the efficacy of the therapeutic value of radiations in cancer therapy. Should local healing continue for five years free of any recurrence, the cure is an anatomic one and complete.

We have kept careful records of the radiation dose applied in 418 consecutive cases of cervical carcinomata. We preserved the microscopic sections and maintained a thorough follow-up system. The percentage of squamous-cell carcinomata was 60, of unripe basal-cell carcinomata, 15, and of adenocarcinomata, 25. The middle ripe carcinomata are included in the first group, as they show evidence of progressive differentiation and tendency to maturity. They amount to 12 per cent. By means of the isodoses of radium, the absorption graphs of *x*-rays, and the anteroposterior and transverse diameters of the pelvis, we calculated the radiation energy applied.

In 40 cases of squamous-cell carcinomata we had 15 cases of primary healing and absence of carcinoma cells from the tissues, i.e., 37.5 per cent. In the group treated with about 80 per cent E. S. D., the percentage of primary healing was 14.3; in the 100 per cent group, 25 per cent; in the 130 per cent group, 66 per cent; and in the 150 per cent group, 80 per cent. In 10 cases of unripe basal cell carcinomata treated with about 100 per cent E. S. D. we had 5 primary healings, i.e., 50 per cent, and in 16 adenocarcinomata we had 0 per cent healings with 100 per cent, and 66 per cent with 130 per cent E. S. D. The microscopic examinations are reproduced in the accompanying illustrations. Figures 2 and 3 represent an unripe basal-cell carcinoma before and after treatment. Figures 4, 5, 6 and 7 an adenocarinoma; and Figures 8 and 9 a squamous-cell carcinoma treated with 100, 130 and 175 per cent E. S. D. respectively.

We cannot as yet draw any conclusions concerning the future behavior of these primarily healed cases. However, we shall arrange all the cases treated statistically and publish them in a second communication.

We may be permitted to draw the tentative deductions that the lethal carcinoma dose for unripe basal-cell cancers is about 100 per cent E. S. D.; for adenocarcinomata about 130 per cent, and for squamous-cell carcinomata, 150 to 170 per cent E. S. D.

CONCLUSIONS

1. The cell types of cervical carcinomata may be conveniently divided into three groups: The unripe basal-cell, the squamous-cell and the cylindrical-cell adenocarcinoma.

2. The radiation sensibility of these three cell types differs. It is greatest in the immature basal-cell type; less so in the adenocarcinoma and least in the squamous-cell carcinoma.

3. The prognosis of the efficacy of radiation therapy in cervical carcinomata must be based on (*a*) the measured radiation dose; (*b*) the changes occurring in the blood, particularly in the nitrogen constituents and the behavior of the white blood corpuscles; (*c*) a careful clinical examination to determine local healing; (*d*) repeated microscopic examinations made before and after treatment.

4. An attempt has been made to express the lethal carcinoma dose for each cell type of cervical carcinoma in per cent of the full 100 per cent erythema skin dose.

BIBLIOGRAPHY

1. Exner, Alfred. Über die Behandlung von Oesophagus-Karzinomen mit Radiumstrahlen (4). Über die Art der Rückbildung von Karzinommetastasen unter der Einwirkung der Radiumstrahlen (7). *Wien. klin. Wchnschr.*, 1904, Nos. 4 and 7.
2. Caan, Albert. Über Radiumbehandlung der bösartigen Geschwülste. *München. med. Wchnschr.*, 1909, No. 24, p. 42.
3. Finzi, N. S. Radium Therapeutics. London, 1913, p. 41.
4. Janeway, Henry H. Radium Therapy in Cancer. Hoeber, New York, 1917.
5. Wickham, L., and Degrais, P. Radiumtherapie. Berlin, 1909.
6. Ewing, James. Radium therapy in cancer. *J. Am. M. Assn.*, 1917, xlviii, 1238.
7. Weinbrenner E. Die Behandlung der Genitalkarzinome mit Mesothorium. *Monatschr. f. Geburtsh. u. Gynaek.*, 1914, xxxix, 181.
8. Kelly, Howard A., and Burnam, Curtis F. Radium in the treatment of carcinoma of the cervix uteri and vagina. *J. Am. M. Assn.*, 1915, xlv, 1874.
9. Kehrer, E. Die wissenschaftlichen Grundlagen und Richtlinien der Radiumbehandlung des Uterus Karzinoms. *Arch. f. Gynaek.*, 1918, cviii, 504.
10. Lahm, W. Über den Einfluss von Radium-Mesothoriumbestrahlung auf das Cervix-Karzinom. *Monatschr. f. Geburtsh u. Gynaek.*, 1914, xxxix, 279.
11. Kehrer, E., and Lahm, W. Über die Grenzen der Radiumtherapie des Kollumkarzinoms. *Strahlentherapie*, 1920, x, 3.
12. Clark, John G. The therapeutic use of radium in gynecology. *Surg., Gynec., & Obst.*, 1918, xxvi, 619.
13. Schmitz, Henry. The action of radium on cancers of the pelvic organs. A clinical and histological study. *J. Am. M. Assn.*, 1915, lxv, 1879.

14. Alter, Nicholas M. Histological changes in squamous cell carcinoma of the cervix of the uterus after radiation. *J. Med. Research*, 1919, xl, 241.

15. Alter, Nicholas M. Histological changes of the different types of carcinoma after exposure to radium. *J. Med. Research*, 1920, xli, 439.

16. Lahm, W. Die Bedeutung der mikroskopischen Untersuchung für die Behandlung und Prognose des Collumkarzinoms. *Verhandl. d. deutsch. Gesellsch. f. Gynäk.*, 1922, 264.

17. Schmitz, Henry, and Huth, Erich. The determination of isodoses of short radium capsules. New York, 1922.

18. Kupferberg. Neue Wege in der Krebsbehandlung. *München. med. Wchnschr.*, 1923, lxx.

19. Schmitz, Henry. The classification of uterine carcinomata for the study of the efficacy of radium therapy. Am. J. Roentgenol., Aug., 1920, vii, 383.

20. Schmitz, Henry. Technique and statistics in the treatment of carcinoma of the uterus and contiguous organs with the combined use of radium and *x*-rays. Am. J. Roentgenol., Oct., 1922, ix, 662.

21. Theis, Ruth C., and Stone, Wm. S. Chemical composition of blood in cancer. *J. Cancer Research*, 1919, iv, 349.

22. Hirsch, Edw. F., and Peterson, A. J. The blood with deep roentgen-ray therapy: hydrogen-ion concentration, alkali reserve, sugar and non-protein nitrogen. *J. Am. M. Assn.*, 1923, lxxx, 1505.

23. Freund, Ernst, and Kaminer, Gisa. Über die Beziehungen zwischen Tumorzellen und Blutserum. *Biochem. Ztschr.*, 1910, xxvi, 312. See also *Wien. klin. Wchnschr.*, 1919, xxxii, 1105.

24. Herly, Louis. A critical investigation of the Freund-Kaminer reaction. *J. Cancer Research*, 1921, vi, 327.

25. Coca, Arthur F. A study of some diagnostic reactions for malignant tumors. *J. Cancer Research*, 1917, ii, 61.

DISCUSSION[1]

Mr. L. B. Clark, San Francisco, Calif. After listening to these two papers I think there is little left to say and from the standpoint of the physicist I feel that I cannot add anything.

Dr. H. H. Bowing, Rochester, Minn. I have enjoyed these two papers immensely. There is no doubt that our work depends on just such studies. I have always been impressed with the work of Alter. Certainly we can all learn much from his Studies I and II.

Just what is the basis of it all, and what brings about this cellular reaction in the carcinoma cell and body tissue is a complex question. I think we will have to continue in theory until we know more about our biologic and microchemical reactions. Much depends on our knowledge of colloidal chemistry, and it is possible that much of it can be carried out in the laboratory in various ways.

It seems that the radiation reaction as we see it in the tissue, as we know the entity of the radium tube, is comparable to that of penetrating heat. It seems that it would be justifiable to compare the reaction in the heat sense, for we know that the energy of the radium and roentgen tube can be measured in terms of heat units.

As to the sections for study, I have always been very anxious, perhaps too much so, to take tissue for study. I think we should be very careful. Most of these patients are poor risks and the chance of hemorrhage and metastasis through manipulation is very great. If we jeopardize these patients the chance for improvement is very slight, but I think it is justifiable to take sufficient biopsy material for study. If one of my patients is doing well and a section is removed, and at the same time a radium tube placed in close proximity, the next morning the patient's temperature will be 100 to 104° F. We must be very careful on account of the danger of bleeding and infection.

As to the fibrosis, we know that the radium dose that will destroy a carcinoma cell will also induce fibrosis, and an over-production of fibrous tissue must be avoided.

It is encouraging to see some of these inoperable patients return in four to six months apparently cured of their carcinoma. They will respond locally to small repeated doses of radium. It is my custom to place a 50-mgm. tube for a period of fourteen hours, and then repeat at intervals of from two to three days until a 4000 or 9000 total mgm. hour dose is built up. Each interval will help to decide how far to push the treatment. In this manner, many portions of the tumor may be treated, including the deep-lying portions. If we fail, it is probably because the deeper areas of the cervical canal and fundus did not get sufficient treatment. As these patients first present themselves, it is impossible in many cases to place the radium tube deep in the cervical tissue without traumatizing the part, but as time goes on, new portals open up. In my experience the broken dose method is more effective than the intensive single-dose application.

I have never employed needles in primary carcinoma of the cervix. I try to avoid all trauma, using the natural channels for the introduction of the radium tube. As the days go by, these tumors degenerate and new avenues open up, and with care the radium may be placed deeper in the involved area. I am confident that the broken-dose method, administered in from two to four weeks, will always bring satisfactory results.

The eosinophilic infiltration following radium treatment is very interesting. I recall a case of splenomegaly in which splenectomy was performed. About two weeks before the operation radium was applied to the splenic enlargement; the tumor was reduced two-thirds in size by the time it was removed. Many sections were studied. The pathologist's comment was that he had never seen so many eosinophiles in any given spleen, and no doubt this was the result of the irradiation.

---

[1] This discussion has reference to the preceding paper by Dr. Withers, as well as to the above.

Concerning the use of a few animals for our laboratory studies, we must be guided by what Wood has shown us: that sarcoma or carcinoma of certain animals may "take" readily in certain months of the year, while in other months the "take" is practically nil. I feel sure that the results should be questioned and the experiments repeated if investigations are carried on with a small group of animals. Such experimentation should be done in laboratories where they have a large amount of material. These variations could easily be attributed to the experimental substance employed, but it would be necessary to rule out the above factor or natural variation before any conclusions could be drawn. It is probable that the chemistry of the patient with carcinoma is comparable to that of the pregnant woman. If pregnancy is considered as a pathologic condition, reaction and many other associated features should be considered, but to me the condition appears physiologic; therefore a plan must be evolved to demonstrate a pure physiologic process.

Dr. D. W. Montogomery, San Francisco, Calif. I did not quite understand the remarks of Dr. Bowing regarding the seasonal variation in the experimental animals.

Dr. Bowing. The work of Wood at the Crocker Institute in New York City is very interesting. Wood can demonstrate with charts showing the number of "takes" in a twelve-month period. There are wide variations; some months the successful inoculations will be very great and in other months they will be very few; this is independent of season and many control factors. It is tedious to explain. A man may be working on 100 animals in a month, injecting, for example, a colloidal material, and may see this reaction or variation. He may conclude: "This is what is doing it; I have found something worth while," but Wood will see these great variations without doing anything to influence the animal. I repeat, therefore, that we must be very careful about accepting the conclusions based on a small number of animal experiments.

In injecting active carcinoma material to bring about "immunity," one must proceed with much trepidation, since animal experimentation demonstrates that immunity does not occur, but instead, wider dissemination and metastasis, and death to the animals.

Dr. W. H. B. Aikins, Toronto, Ont. These highly scientific papers, which show wonderfully good work, will give the men who are using radium a better basis for their clinical endeavors, and we feel much enlightened and encouraged. Their findings are absolutely up-to-date so far as radium therapy is concerned. They both speak with authority. I quite concur with Dr. Withers in his remarks regarding the propaganda in connection with cancer control, that this propaganda is apparently being put forward very largely by those having a strong surgical view, who do not take proper cognizance of the beneficial results obtained by roentgen rays and radium. I hope Dr. Withers' remarks will be given wide publicity.

Dr. Montgomery. We suppose the gamma rays act on the tissue cells in the following way:

In the first place, gamma rays are noxious to all cell life when given in sufficient dosage. The tissue cell consists of a body and a nucleus, and the nucleus is surrounded by a perinuclear case or membrane, which affords it protection. The nucleus is the life center of the cell. In cell division the perinuclear membrane vanishes, and the whole contents are scrambled within the cell. During the time of this cell division the nuclear elements are exposed, and consequently the cell is much more susceptible to the noxious influence of the gamma rays. As the cells in a malignant growth are in more active division than those of normal tissue the gamma rays kill them more readily, and as a rule they are seven times more lesionable than the normal cells.

It follows from the above premises that treating a malignant growth with gamma rays is comparable to sterilizing a culture medium by fractional sterilization. The cells which are in active division today are killed by today's dose of radium, and those of tomorrow by tomorrow's dose, and so on.

Dr. H. J. Ullmann, Santa Barbara, Calif. I would like to add a little something to emphasize what has been said concerning variations in transplants in animals. On Thursday I had the pleasure of visiting Dr. Evans in the department of anatomy at the University of California, to get some rats for similar work. He urged not only that I keep a standard diet, but that the components themselves be standardized. He has found that variation in diet as well as seasonal change may make any work almost valueless. This is speaking of work with rats especially. Anyone interested will find it very profitable to go to Berkeley and see the work of Dr. Evans and talk to him along this line.

Dr. Bowing. Again referring to Dr. Wood's work: he can show you that very seldom does experimental carcinoma metastasize to the spleen. He explains this phenomenon by the fact that the spleen is a pulsating organ, therefore cells cannot readily lodge to form new growth. The spleen does not produce a substance which will inhibit the growth of the foreign cell. The injection of splenic pulp will not "immunize" an animal any more than the injection of any foreign protein.

Dr. Withers (closing discussion on his paper). My paper attempted to deal briefly with the fundamental principles of radiation therapy from a biologic viewpoint. Much could be said in closing which for the sake of brevity must be omitted. I should like to reiterate a statement made previously that this résumé necessitates making broad statements to which possible exception may be taken, but will in general present the working ideas that we hold in the treatment of neoplastic diseases by gamma and *x*-rays.

Dr. Schmitz (closing discussion on his paper). As far as the removal of the tissue for microscopic examination is concerned, we use a very sharp knife, usually the Parker knife, and make a V-shaped excision from the cervical canal into the vagina. Thus we get a piece of tissue that has the cervical as well as the vaginal mucosa. Of course, there is a great difference of opinion as to whether we should perform a biopsy or not, and I assure you I always do it with a great deal of hesitation. Dr. Ochsner and others are averse to biopsy, stating that they never saw a patient subjected to biopsy who recovered permanently. However, the immediate application of the cautery or radium seals the blood vessels and prevents escape of cancer cells into the blood stream. Microscopic examinations are of the greatest value in the estimation of the efficacy of the radium and roentgen dose.

Dr. Bowing (replying to Dr. Schmitz). My point was that when the patients are first seen, the tumor has so destroyed the anatomy that the cervix cannot be located. The huge mass or ulcerated area will permit the radium tube to be placed in the natural grooves or craters; and then by repeating the treatment once or twice a week the tumor will regress to such an extent that at the end of ten days or two weeks the cervix can be located, and probably the cervical canal can be probed. I have seen the posterior or anterior cervical lips come into view, and then with some assurance that the probe was in the cervical canal, the fundus of the uterus could be palpated, in other words, without traumatizing carcinomatous tissue and yet reaching the deeper portions of the involved area.

Dr. Schmitz (continuing). I believe the cervix to be the best filter for the irradiation that we have, and I insist on the intracervical application of the radium. By placing the patient under nitrous oxid anesthesia there is very little difficulty in exposing the cervix if you use the Sims speculum. You can by careful palpation locate the cervix, and if you know the location of the uterus by bimanual palpation you can place the uterine sounds correctly. Of course, there is always infection present in advanced carcinoma, but these patients have acquired immunity against their own bacteria which they harbor. If infection does occur it is from without. We made consecutive cultures in 250 gynecological cases to study the bacterial flora, particularly in reference to the hemolytic streptococcus. A great many of these patients were operated upon and had a normal convalescence. A few died from septic conditions. The important thing was that none of the patients who had hemolytic streptococci became infected with their own organism, but became infected with an entirely different strain.

I witnessed two post-mortem examinations conducted by Professor Aschoff. In one the radium tube had been pushed into the posterior vaginal fornix and in the other it had gone through anteriorly. Both patients died from a septic peritonitis. The same accident happened twice in our clinic. We placed the patients in bed and watched them carefully, and aside from a slight rise in temperature saw no bad results. I do not wish to say that our methods of sterilization are better than those across the water. Our patients may have had a better resistance, not being undernourished.

We introduced the fractional dose method in 1913, placing the radium capsule for ten or twelve hours every third or fourth day until a certain amount of irradiation had been given. Then we applied the same dose in one sitting, leaving the radium capsule for four days. We did not like the last method. It seemed to prevent individualization in treatment. After that we used seven to eight daily applications, permitting the capsule to remain for ten hours each time. Our present method is as follows:

In order to apply a 100 per cent radiation skin dose to the cervix, three or four fields of *x*-rays are applied. The time duration depends upon the size of the patient. We excise a piece of tissue for diagnosis and insert a 50 mgm. radium element capsule for forty-eight hours. In three or four days we have a complete report on the biopsy, and then we determine the lethal dosage. To a squamous-cell type we give a ninety-six hour treatment and to the basal-cell type a twenty-four hour treatment. We never repeat the treatment. If within six, eight or twelve weeks there is no sign of healing we feel that irradiation will not help the patient.

RESULTS OF DEEP ROENTGEN TREATMENT OF GASTROINTESTINAL MALIGNANCIES*

BY WILLIAM A. EVANS, M.D., AND T. LEUCUTIA, M.D.

Harper Hospital

DETROIT, MICHIGAN

THIS paper deals with our experience in treating malignancies of the gastrointestinal tract with deep radiation for a period of over a year, and is limited to 60 cases. We have elected to present our observations on this phase of our deep therapy work for two reasons:

1. Because the literature is barren of all reference to results obtained by the deep radiation of malignant neoplasms of the esophagus, stomach and intestines, and because there is no available information as to technique, indications, complications, etc., aside from a few brief reports on treatment with radium.

2. Because, contrary to the opinion generally held, satisfactory results were obtained in a fair percentage of cases, not only in controlling many of the unpleasant symptoms, but actually in controlling the extension of the disease itself, and in some cases, the eradication of the disease.

REVIEW OF CASES TREATED

Our series includes 6 cases of cancer of the esophagus; 25 cases of cancer of the stomach; 4 of the cecum; 3 of the sigmoid and 17 cases of cancer of the rectum. We have included in this report 1 case of a primary cancer of the liver, 1 case of late secondary cancer of the liver, with primary in the breast; and 3 unclassified tumors of the upper abdomen which deformed the stomach and resulted in delayed gastric evacuation.

The diagnosis in every case was made on clinical and roentgenological evidence, and in many cases, on operative and microscopical findings. Furthermore, the stomach cases were as a rule classified as inoperable, and several of the rectal cases had already undergone resection, and the cases were referred for treatment of secondaries.

1. *Lesions of the Esophagus.* A review of the results in our cases of lesions of the esophagus shows that of the 6 treated, only 1 is alive. However, in all the cases, studies of deglutition following treatment demonstrated a definite reduction in the extent of the lesion and a resulting improvement in function of the esophagus.

In analyzing the causes of death in the fatal cases, it is recorded that 2 of the cases died from pneumonia as a result of esophageal-bronchial fistula, 2 died apparently from cachexia, and a 5th died suddenly from a cardiac complication. In all these cases the lesion was localized in the middle or lower third of the esophagus; i.e., in a place hardly accessible for the radiation; and only in the 6th case, which is still alive, was the lesion confined to the upper third. This case first came for treatment eight months ago, with enlarged cervical glands, which had a typical carcinomatous appearance, but the primary lesion, although suspected in the upper portion of the esophagus, could not at that time be demonstrated. The enlarged cervical glands only were treated, and they disappeared promptly after the treatment. Two months later, the patient returned for examination, complaining of difficulty in swallowing. Examination at this time revealed the presence of a typical carcinomatous lesion in the upper third of the esophagus (Fig. 1). This lesion was treated by deep radiation and two months later a disappearance of the lesion could be demonstrated (Fig. 2).

In 4 of the cases treated we used roentgen rays entirely; in 2 cases we applied radium locally in addition. We think the latter method should be preferred whenever possible. Also postradiative dilatation of the esophagus is advisable for a number of weeks following the treatment.

2. *Lesions of the Stomach.* Of the 25 cases presenting gastric lesions, 14 are

---

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

dead and 1 shows no improvement. Of the remaining, a number are clinically well and others show improvement of varying degrees. In 2 of the cases showing marked defects at the original examination, plate studies failed to reveal any evidence of an infiltration of the gastric wall later. Figures 3 and 4, and Figures 5 and 6 show these cases.

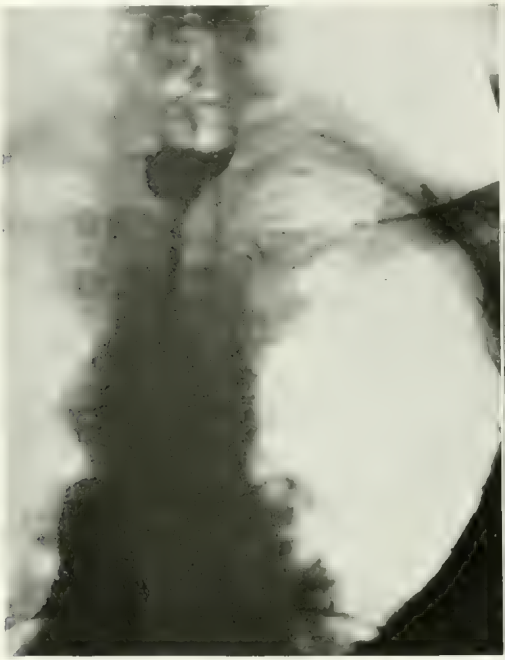


Fig. 1. Carcinoma of the upper third of the esophagus. Partial obstruction of the esophagus by the tumor mass at the level of the sternoclavicular region, the barium mixture remaining in the part of the esophagus above the lesion for five or ten minutes. Beginning dilatation of the upper portion of the esophagus. Considerable enlargement of the cervical glands on the right side.

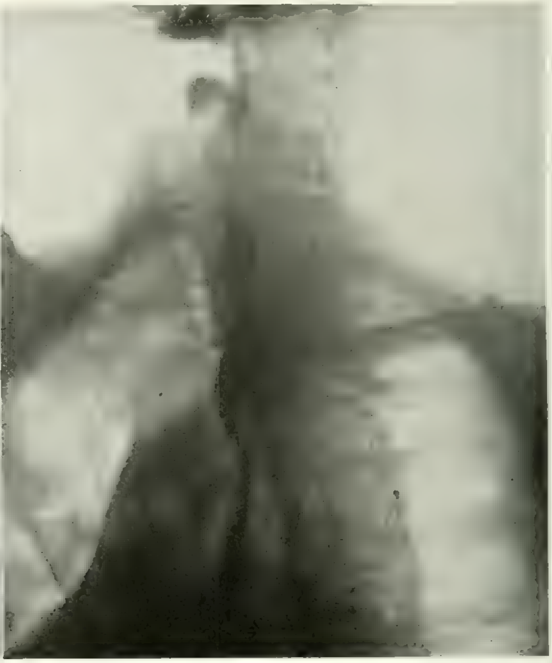


Fig. 2. Same lesion, two months after deep *x*-ray treatment. Normal lumen of the esophagus at the site of the lesion. No obstruction and no retardation of the barium mixture above the lesion. No difficulty in swallowing. The enlargement of the cervical glands has disappeared. This plate was made by flash exposure while patient was swallowing the barium mixture.

In another case, deep *x*-ray treatment was combined with surgery. The tumor being on the pylorus (Fig. 7) a resection of the pylorus was done, together with posterior gastrojejunostomy, but the microscopic examination of this specimen has shown that the lesion, which was a cylindrical-celled carcinoma, has extended beyond the margin of the excision. Therefore, deep *x*-ray therapy was given, following the operation, and the patient has been well for more than a year (Fig. 8).

Of those who died, 3 died within ten days following the treatment. Of the rest, it is reported that they were relieved of pain, vomiting, and hemorrhages for a period of two to six months. In 3 of the cases in which ascites occurred shortly following repeated aspirations, there was a clearing up of the abdominal fluid, without further recurrence. (In this connection we have observed that in 3 other cases showing ascites, with the primary lesion distinct from the gastrointestinal tract, the fluid disappeared following the treatment over the abdomen.)

3. *Lesions of the Intestinal Tract.* In all 4 cases of cancer of the cecum, the results were gratifying, 3 of them being alive after one year, and the condition of the patients showing improvement over that at the time of the original treatment. Of the 3 cases of involvement of the splenic flexure and sigmoid, the patients are alive, and their condition shows clinical improvement.

4. *Lesions of the Rectum.* Of the rectal cases, 9 patients are dead, and the remaining 8 show either improvement or a com-

plete control of the signs and symptoms (Figs. 9 and 10) with one exception, where a rectovaginal fistula developed as a result of the treatment. This case gave a history of tumor of the breast of a carcinomatous nature. After two years there was evidence of a cancer of the uterus, and later a cancer of the lower bowel. The patient had had radium treatment, superficial x-ray treatments, and four months ago a resection of 8 in. of the lower large bowel. About four weeks ago, there was a rapid recurrence of the pelvic tumor, a large mass being discovered between the colon and the uterus. Three weeks following a full carcinomatous dose, this mass broke down and discharged through the vagina. The patient now has a fistulous tract connecting the sigmoid and vagina.

5. *Lesions of the Liver.* We have treated the liver by deep roentgen rays in 1 case of primary carcinoma and in several cases of secondary metastases. The case of primary carcinoma of the liver was in a young woman, thirty-two years of age. The patient was examined by incision one and one-half years ago, but found inoperable and instead, a specimen was taken for microscopic examination. This showed multiple primary carcinoma of the liver, springing from multiple adenoma of the bile ducts. Immediately after the deep x-ray treatment all the symptoms subsided; patient gained 30 lbs., and has been well ever since. Repeated functional tests of the liver were made and these showed normal. The patient has been back at work now, for a period of over a year.

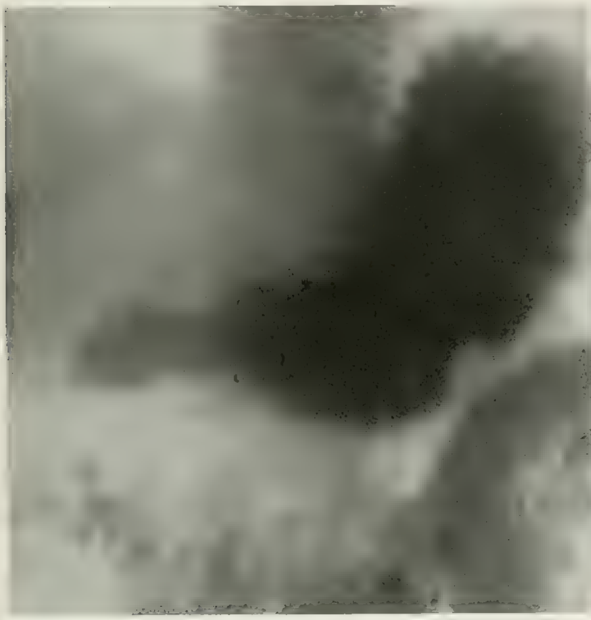


Fig. 3. Carcinoma of the lesser curvature of the stomach. Constant defect in the middle third of the lesser curvature, with irregular outlines. Atonic stomach. Patient rapidly losing weight.

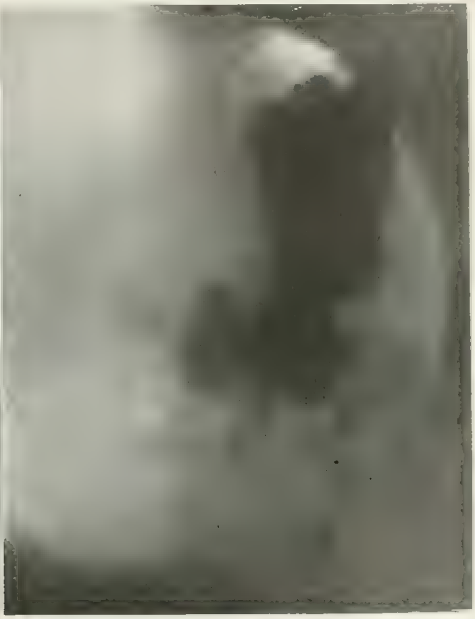


Fig. 4. Same eight months after deep x-ray treatment. Defect has disappeared. Three-wave peristalsis; normal appearance of the stomach. Patient gained 36 lbs. and is without any symptoms.

While secondary metastases of the liver were treated successfully in a number of cases, however, the final prognosis in these cases is not good. In one of our cases, operation was performed eight months ago for carcinoma of the sigmoid. At the operation a large tumor mass of the sigmoid was found with extensive metastases to the liver. Consequently, the patient was declared inoperable and only a colostomy was made. Following a heroic radiation of the whole abdomen and the liver, the patient's condition improved so much that six months later removal of the remaining carcinoma of the sigmoid was made, and the patient is now without any symptoms. In another case, where we treated the liver for metastases, the primary lesion was in the breast. Radical operation of the breast was performed two years ago, without local recurrence. But, two years later, metastases developed in the liver and abdomen with accompanying ascites. Following deep radiation, the liver is reduced to almost normal size, the ascites has disappeared and the patient's condition is greatly improved (Figs. 11 and 12).

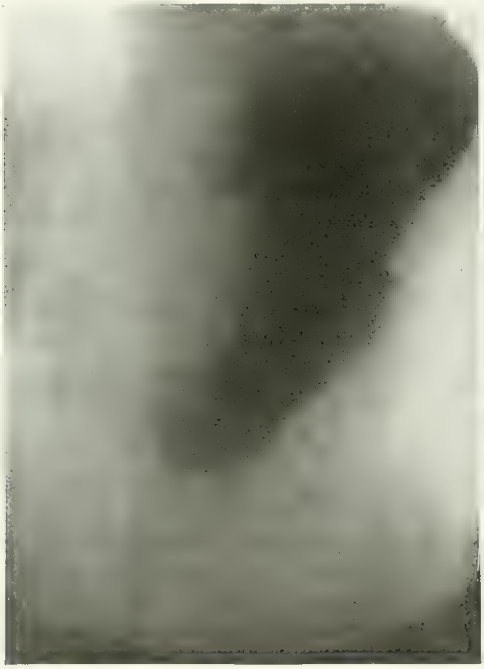


Fig. 5. Carcinoma of the lesser curvature of the stomach. Large filling defect extending along the greatest part of the lesser curvature. Indefinite contour of the pylorus. Viewed laterally, the stomach shows irregularity of the anterior wall. There is no evidence of peristalsis. Patient rapidly losing weight.

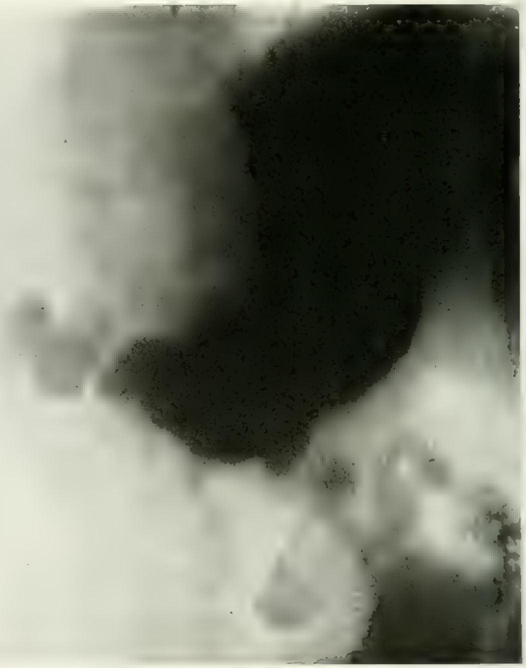


Fig. 6. Same nine months after deep *x*-ray treatment. Normal outline of the stomach. Two-wave peristalsis. Patient gained 20 lbs. and is without any symptoms. (Note. This patient has recently developed lung and pleural metastases, and died as a result, one year after the deep *x*-ray treatment was given. The stomach remained normal.)

6. *Unclassified Lesions.* In the unclassified cases, one was apparently a tumor of the pancreas with involvement of the biliary tract, with resulting jaundice. At the time of beginning the treatment, the patient could retain no food, and was completely prostrated; but after the reaction from the treatment, there was a rapid return to health. The patient remained well for eight months, when there was a return of the jaundice. Following a second series, the symptoms again cleared. In a second unclassified case there was a large upper right quadrant mass which deformed the stomach (Fig. 13) but was apparently not of the stomach; there was a twenty-four hour residue and the patient was reduced to 75 lbs. Following the treatment there was a gradual improvement in her symptoms, and at this date she weighs 40 lbs. more than at the time of beginning the treatment, and has no untoward symptoms. The plate at this time shows no pressure defect on the stomach, and there is a good rate of gastric evacuation (Fig. 14).

A third unclassified case was a deforming lesion of the stomach and duodenum, probably from a retroperitoneal lymphosarcomatous gland. The patient had lost 100 lbs. in weight and presented symptoms suggesting pressure on the pancreatic duct. Twenty-four hours following the first dose, there was a reduction in the size of the tumor, and in four days no defect of the stomach was demonstrated.

TECHNIQUE

1. *Localization of the Lesion.* It is extremely important that the exact localization and extension of the lesion be made before deep therapy is undertaken, and all diagnostic means should be used in order to determine this. Preliminary gastrointestinal examination by means of the barium meal was used as a routine measure, and wherever possible, an exploratory was done, and if the case was at all operable the surgical indications were carried out. In these cases combining surgery, the tumor was localized with the aid of the surgeon, and the extent of the lesion was projected on the skin surface.

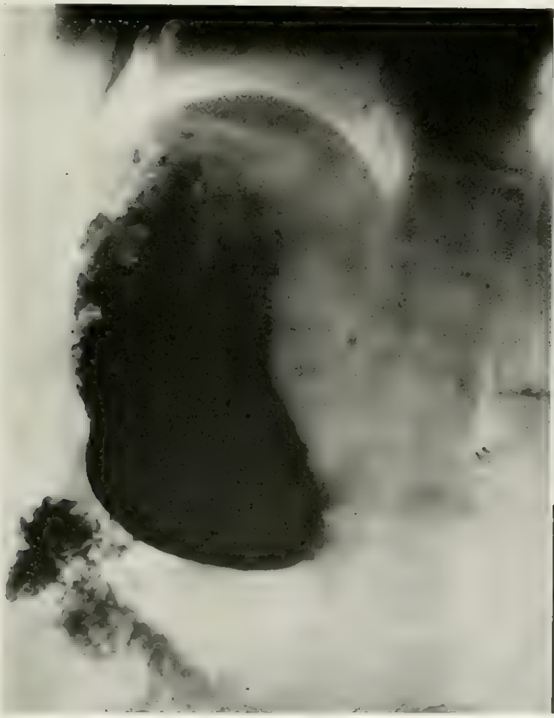


Fig. 7. Carcinoma of the pyloric end of the stomach (microscopically, cylindrical-celled). Five-hour plate, showing about 80 per cent gastric residue and the presence of an annular lesion at the pylorus. Patient rapidly losing weight.

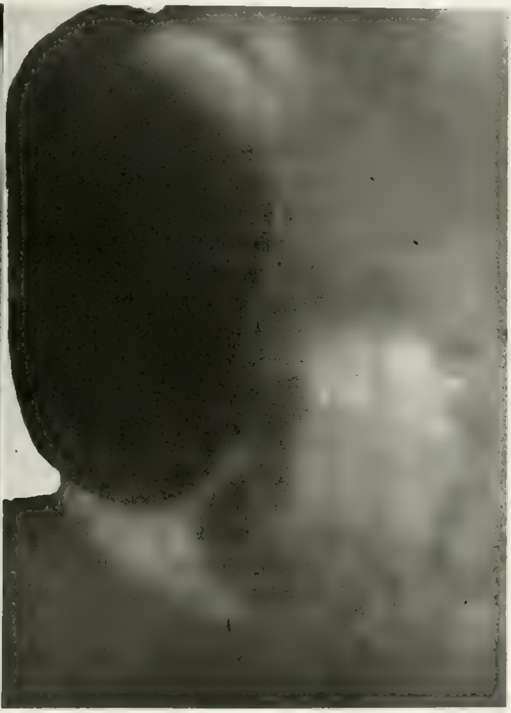


Fig. 8. Same, one year after deep *x*-ray treatment, combined with resection of the pyloric end of the stomach. No evidence of any malignant infiltration. Stomach functioning well. Patient gained 25 lbs. and is without symptoms.

2. *Preparation of the Patient.* The gastrointestinal tract should be empty during the exposure of the patient to radiation. If previously a barium meal was given for examination, this should be removed by purgatives or enemata, so as to prevent unnecessary secondary radiation of the bowel mucosa from the barium.

We find it advisable to put the patient on a fat and acid-free diet, and to prescribe alkalies during the treatment, so as to combat the acidosis. In cases with the nervous symptoms predominating, morphine or other sedatives may be administered, but as a rule this medication increases the nausea. Therefore we prefer to avoid the administration of such drugs, whenever possible.

A preliminary blood examination should be made in every case. A low red cell count or a low hemoglobin index does not contraindicate treatment, for in cases of cancer of the stomach hemorrhage is a common symptom, and there is a tendency for the deep therapy to control these hemorrhages. In one case with a far-advanced carcinoma of the stomach the blood count by repeated examinations showed only 300,000 red blood-cells. Imme-

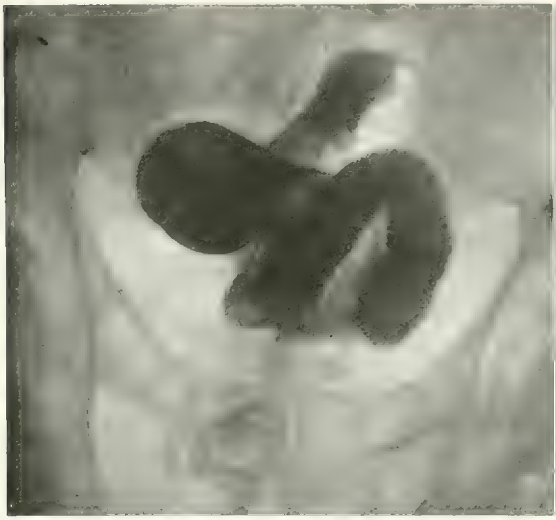


Fig. 9. Carcinoma of the rectum. Definite filling defect in the lower portion of the rectum, due to obstruction by the tumor.

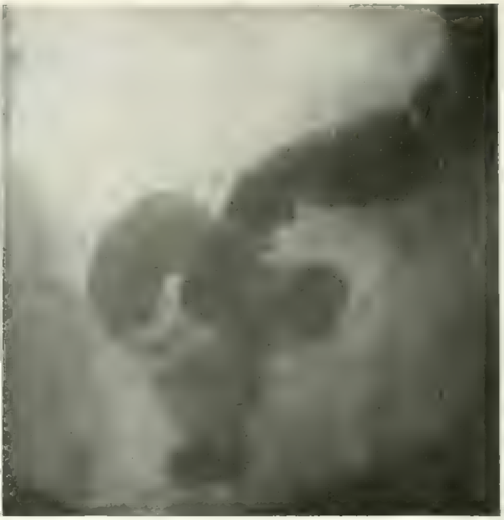


Fig. 10. Same, five months after deep x-ray treatment combined with radium. Lesion almost entirely disappeared. Good filling of the rectum. Patient symptomless.

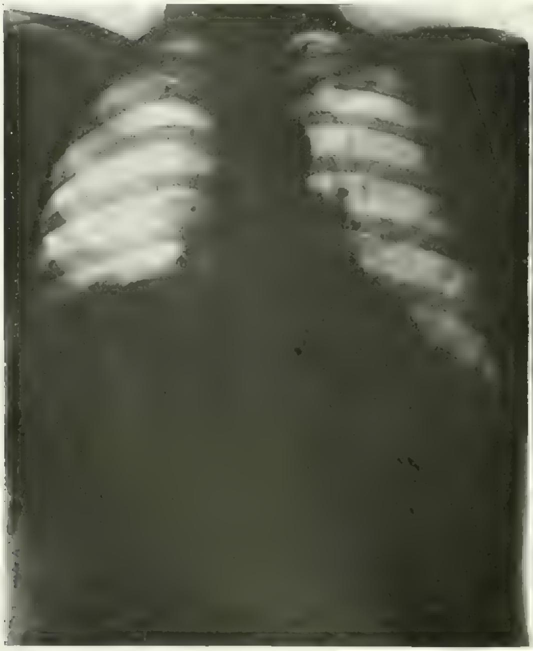


Fig. 11. Metastatic carcinoma of liver, omentum and lower part of right lung after carcinoma of breast removed two years ago. The right diaphragm leaf is considerably pushed up as a result of the liver enlargement. Two metastatic noduli visible in the lower part of the right lung field. The lower border of the liver reached as far as the right iliac crest. Ascites; marked cachexia.

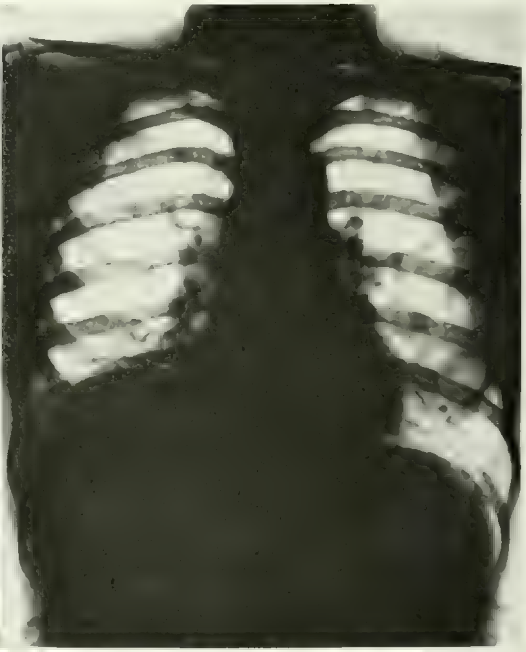


Fig. 12. Same, three months after deep x-ray therapy. There is normal height of the right diaphragmatic leaf. Metastatic noduli in the lower part of the right lung disappeared. Lower border of the liver almost normal. Ascites disappeared. Patient gained about 20 lbs. Condition very much improved.

diately following the treatment there was a gradual improvement in the blood condition and this improvement was maintained. The patient lived three months after the treatment, and all of his symptoms during that time were under control. In this case the red blood count increased to 800,000 within a week of the treatment, and this, we believe, was due both to control of the hemorrhage and the possible stimulation of the spleen from the scattered radiation.

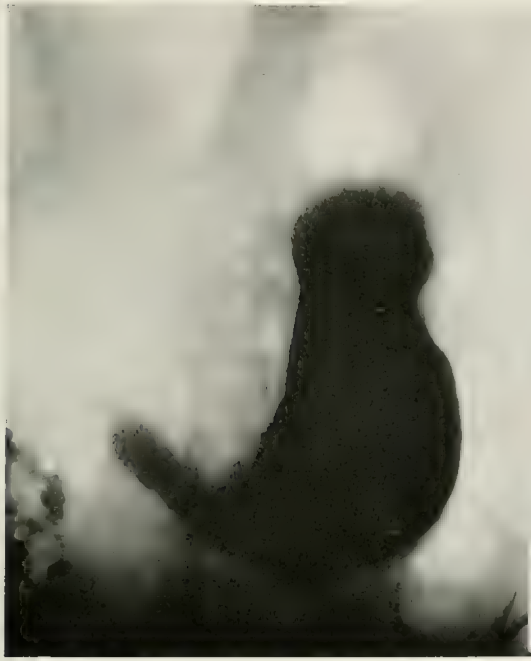


Fig. 13. Malignancy of the upper right quadrant; exact type not determined. Because of the far-advanced age, no laparotomy was possible. There is marked pressure defect of the lesser curvature of the stomach, with 80 per cent gastric residue at five hours', and about 30 per cent residue at twenty-four hours' examination. A large tumor mass, the size of a pineapple, is palpable in the right upper quadrant. Patient's condition is rapidly deteriorating.

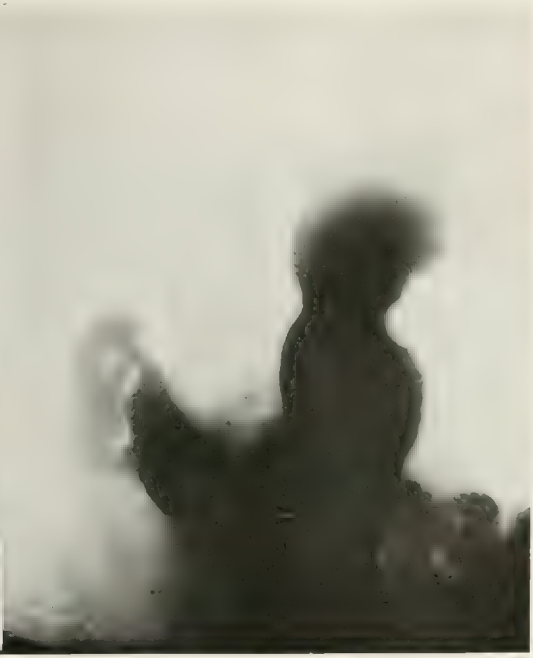


Fig. 14. Same, nine months after deep x-ray treatment. Pressure defect of the stomach has disappeared. Normal appearance of the stomach with normal rate of evacuation. No tumor mass is palpable in the abdomen. Patient gained 40 lbs. and is without any symptoms.

3. *Dosage.* In all gastrointestinal carcinomata, we project as much as 110 to 130 per cent of the skin erythema dose over the lesion, and over the secondaries, if present. This, of course, has to be given through several portals of entry, using the cross-fire method. We have confined our treatment to the following factors: 200,000 volts (peak), with 1.3 mm. Cu. and 1 mm. Al. filters, large portals of entry (20 × 20 cm.) the skin target distance varying from 40 to 60 cm. The effective wave-length of the rays produced under these conditions is $\lambda_{eff.} = 0.137$ A.U. (using Duane's table) and at a 50-cm. skin target distance, the depth dose (10 cm. below the skin) = 45 per cent. We found that the determination of the distribution of the intensity of the rays at different depths of the tissues is a very important factor and therefore it should be determined individually for every installation under all conditions to be used; such as when changing filters, size of fields, skin target distance etc. We found that by using the different so-called "intensity charts" now on the market, without control-measurements and adaptation to one's own installation, grave errors may be committed; and this, of course, greatly influences the results to be obtained. At the beginning, we used the Dessauer-Vierheller charts, which are the most commonly used, but soon we found that the figures on these charts are too

high for American transformers, and that the patients treated, using the calculations of these charts, are far under-dosed. For the conditions mentioned above, for example, the Dessauer-Vierheller charts indicate a depth dose of 56 per cent, which for a lesion lying 10 cm. below the skin and cross-fired through three portals of entry makes a total difference of over 30 per cent. Such an underdosage of the lesion would not produce the biological reaction desired, and in consequence the results would not be the ones expected. Dr. Glasser explains in detail the reason of these differences in the measurements, and he arrived at the conclusion that it is mainly due to the measuring of the coefficient of weakening μ_{water} which is used in the Dessauer-Vierheller charts for the characterization of the quality of the rays. It is certain that by using Dessauer or any other intensity charts for measuring the dosage to be administered, an adaptation of these charts to one's own installation is more than necessary.

With regard to the administration of the dose, we think it should be given in as short a time as possible; but in cases where marked anemia is present as a result of severe cachexia, the treatment should be prolonged and time should be given the patient between the treatments to absorb part of the destroyed tissues.

4. *Repetition of Treatments.* Our experience is that such a massive dose given in one single series cannot be considered as a "killing dose" and a repetition of the treatment is necessary. Usually the reaction following the projection of such a dose is so severe that it persists for several weeks. Therefore, it is only rarely possible to repeat the treatment earlier than two months after the first treatment. Eight to twelve weeks is the usual time before the patient returns to normal condition. A careful examination of the blood and of the bowel function is necessary before a repetition of the treatment is decided upon. If the blood pictures have not yet returned to normal, that is, to the state where they were before the first treatment was given, or if the patient still shows signs of disturbed bowel function, under no condition should the treatment be repeated. In 2 of our cases, because of the very rapid spreading of the cancer lesion, we disregarded these rules and both patients died ten days following the second exposure. We could not determine in these 2 cases the exact cause of death, but we concluded that it was due to too early application of the second dose.

5. *Damage of Normal Tissues during the Exposure.* In treating malignancies of the different parts of the gastrointestinal tract, we expose, of course, normal tissues; and due regard must be paid to these structures.

(*a*) When treating lesions of the esophagus, the exposure of the *lungs* should be avoided as much as possible. The lesion should be cross-fired through the different portals of entry in such a way that very little of the lung fields should be exposed. It is now generally recognized that heavy radiation of the lungs produces fibrosis of these organs, which in cases of exposure of both sides may be fatal to the patient.

(*b*) In the treatment of lesions of the stomach, or of the upper quadrants of the abdomen, especial attention should be given to the *suprarenal glands,* for over-radiation of these organs may produce death in comparatively few days. It has been determined that 70 per cent of the skin erythema dose over both suprarenals is usually fatal. In one of our cases, following three exposures of the upper abdomen, such a severe suprarenal disturbance appeared that we had to interrupt the treatment. The blood-pressure increased from 120 to 260 in three hours and the patient manifested severe toxic symptoms. However, no permanent damage was done in this case because the patient has fully recovered and has remained well after four months. While it is not always possible to protect absolutely both of the suprarenals, it is of the greatest importance that one be left outside of the field of radiation. In order to determine the exact situation of these organs, we usually locate, radiographically, the position of the kidneys and then draw conclusions as to the relation of the suprarenal bodies. In none of our cases of carcinoma of the stomach did we detect symptoms that could be explained by suprarenal disturbance.

(*c*) Due regard must be had for the *mucous membrane of the intestines*, when treating lesion of the intestinal tract. 140 per cent of the skin erythema dose is considered as the lowest limit supported by the mucosa of the large intestines without serious destruction. If diarrhea appeared ten days after the treatment and lasted for two or three days, this is a sign that a proper dose was given over the lesion. Where the dose exceeds 140 per cent of the erythema dose, serious damage will be done to the intestinal mucosa. If there is evidence of such serious injury to the mucosa at the time of the first series the dose given at the second series must be definitely limited.

(*d*) In none of our cases have we had any permanent damage done to the *skin*. In some hypersensitive patients we get erythema of the second degree, but this is easily and satisfactorily controlled by Dodds' mixture. By using proper technique, the possibility of skin damage is so minimized that this question can be entirely disregarded.

6. *Postradiative Treatment.* In treating malignancies of the esophagus there is a profound reaction manifested by dysphagia and spasm with intensive pain on swallowing. Anodynes should be administered in these cases and regular two-hour feedings by soft diet should be introduced.

After the treatment of carcinoma of the stomach or of the intestinal tract, there is usually a very severe nausea and vomiting for two or three days following the treatment. To control these symptoms it is necessary for the patient to lie absolutely quiet in a well-ventilated room, and alkalies (bicarbonate of soda, tribasic citrocarbonate, etc.) should be administered in order to combat the acidosis. The application of ice bags over the abdomen will also greatly relieve the symptoms. The administration of cerium oxalate in combination with essence of pepsin often relieves nausea. In very far-advanced cases, hypodermoclysis should be done every two or three days, in order to facilitate elimination of the toxins. Also rectal feedings should be given. The symptoms of the reaction following the treatment usually last from three to four weeks, and only then does the condition of the patient start the return to normal.

CONCLUSIONS

1. Deep *x*-ray therapy, in combination with surgery, or alone, is indicated in all malignancies of the gastrointestinal tract.

2. Palliative results are obtained in a large number of cases, in controlling many unpleasant symptoms and checking temporarily even the extension of the disease itself.

3. Eradication of the disease may be expected in early cases, especially when combined with surgery. Considering the short period of observation (one year) no statement can be made as regarding recurrences.

4. A careful measurement of the dose to be given is necessary. One single massive dose of deep *x*-ray cannot be considered as a "killing dose." Treatment should be repeated in six to twelve weeks.

5. Exact localization of the lesion, preparation of the patient, and careful postradiative treatment are very important parts of a successful deep *x*-ray treatment of the gastrointestinal lesions.

6. Normal tissues should be protected. Special attention should be given to the lungs, suprarenal bodies and the bowel mucosa. The skin damage is minimized to almost nothing.

TREATMENT OF A CASE OF PRIMARY MEDIASTINAL TUMOR OF THE LUNG BY X-RAYS AFTER MEDICAL RESOURCES WERE EXHAUSTED*

BY FRED S. EVELETH, M.D.

CONCORD, NEW HAMPSHIRE

THE importance of making a thorough physical, chemical and *x*-ray examination of every doubtful case is being more and more emphasized by the medical profession and demanded by the laity of the present day.

The *x*-ray man has his difficulties in differentiating positively certain pathological lesions. He cannot be too certain of any lesion without the proper presentation of the clinical side of the case and a thorough knowledge of the differentiation of similar shadows. It is interesting to observe how rapidly certain pathological lesions of the lungs are being differentiated and classified, but we shall always have certain exceptions to the general rules, and many conditions are complicated.

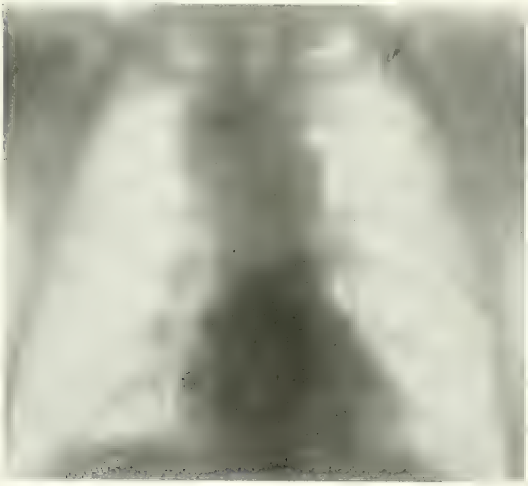


FIG. 1. Made May 15, 1920. Shows a definite, smooth, elliptical shadow just opposite the arch of the aorta. Diameter of the large blood-vessels and tumor measures 9 cm.

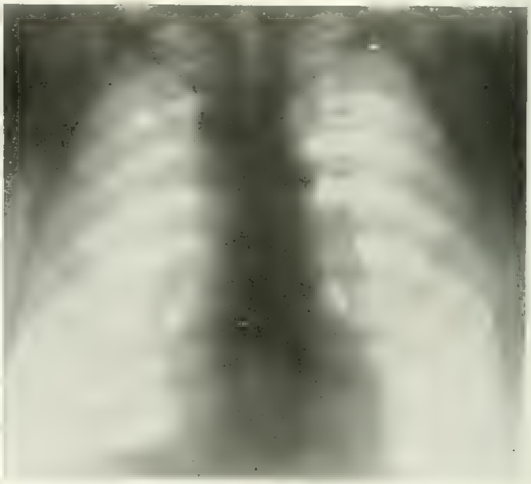


FIG. 2. Made July 17, 1920. Shows the area of increased density decreasing in size in all directions. Large blood-vessels and tumor measuring 7.3 cm.

I wish to add another to the many already reported cases of intrathoracic shadow arising from the mediastinum; presumably a primary mediastinal tumor. From the roentgenogram of the chest presented, one might consider the area of increased density due to a caseating brachiobronchial gland, aneurysm or a benign or malignant growth. To the patient, the correct and early diagnosis is most important before the area could grow larger, or, if malignant, before there is danger of metastasis.

This case is interesting because of its history and the apparent successful results of *x*-ray therapy after other medical procedures failed.

CASE REPORT

Male, American, fifty-two years old, employed as a section-hand on the railroad, height 5 ft., 9 in., weighing 138 lbs. on May 15, 1920. His family history is negative. He has a marked cachectic appearance and sallow complexion with a history of progressive increasing weakness and loss of weight (lost 6 lbs. during the previous month). He is very nervous from constant coughing, shortness of breath and pressure effects.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1922.

This cough, he states, started twelve years ago in the springtime. At first this irritation would subside in the summer season and then return in the fall and winter. He has had the persistent, irritating cough all the time for the last four or five years. The sputum is negative as to tuberculosis, and there has been no discolored sputum at any time, nor could I solicit the record of his having had a temperature at any time, nor any palpable glands in the neck or other location.

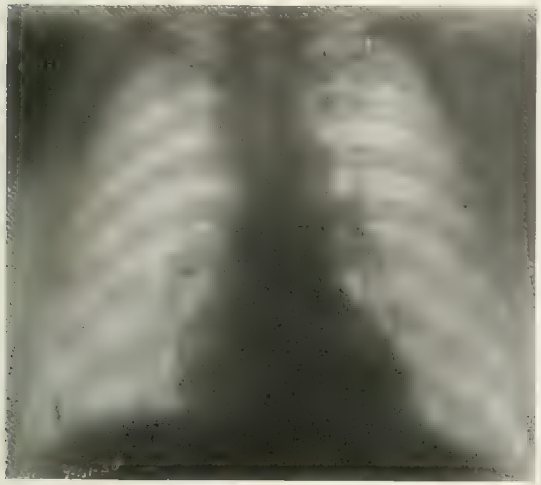


Fig. 3. Made September 21, 1920. Tumor shadow has practically disappeared.

The patient was thoroughly examined, with the following report:

"With the patient on the left side one can hear, in the third interspace in the third mid-clavicular region, when he has blown out his breath and held it, a loud systolic murmur in this area. The question was raised at once of the possibility of there being an aneurysm, based on a luetic aortic infection."

He had been treated for lues several years ago with a course of "606." At present he has a negative Wassermann test. Mercury was given without improvement.

The patient said he had typhoid fever in the fall of 1919.

On making a fluoroscopic and plate examination at this time I found the following: A rounded mass extending upward and outward from just above the arch of the aorta on the right. I was unable to get definite pulsation, corresponding to the pulsation of the arch. In the plates taken an elliptical mass is seen on the right; it extends from the inner border of the fourth rib posteriorly down to the seventh interspace posteriorly. It is more in front, and extends out about 2 in. from the median line; its border is perfectly smooth, while that with the aorta shows a pulsation and is somewhat hazy.

Doubtless this is a new growth rather than an aneurysm. The trachea is not displaced and comes down in the median line between this and the aorta; the lungs are otherwise normal.

A roentgenogram of the heart taken 7 ft. from the target shows its shadow within normal limits. The apex is under the sixth rib, 8.2 cm. to the left of the median line. Long diameter of the heart 14.8 cm. Transverse diameter 13.6 cm. Diameter of the great blood-vessels 6 cm. Diameter of the great blood-vessels and tumor shadow 9 cm. Diameter of the chest 28.5 cm.

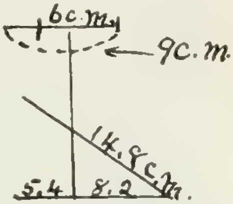


Fig. 4. Shows the diagram of the heart measurements taken from a target distance of 7 ft.

Treatment. After the first deep *x*-ray treatment the irritating cough began to lessen, and the patient improved steadily both in weight and strength, treatments being given directly over the mediastinum and occasionally over the right supraclavicular region, also through the back toward the mediastinum.

Roentgenograms of the heart were taken 7 ft. from the target, two months apart for a time, showing gradual disappearance of the mediastinal tumor.

Treatments were given at intervals of three weeks from May 15, 1920 to August, 1920, using 8½ in. spark-gap with 4 mm. Al. and a thickness of sole leather for filters, and using a 10 in. anode distance, and 25-30 ma. min. The patient gained in weight from 138 to 160 lbs. The treatment was lengthened to once a month for three months, after which he was given a rest of three months. In February, 1921, the patient called my attention to two palpable infected lymph-nodes the size of English walnuts in the left supraclavicular region, which area I had not treated previously. I was hoping one of these glands might be removed for diagnostic purposes; but the patient objected, and after two treatments by the *x*-ray alone one month apart, these disappeared.

The patient reported in September, 1921, when I could see no evidence of the malady, and again on April 28, 1922. He tells me he weighed 206 lbs. in January, 1922, when his physician advised him to restrict his diet.

NOTE. September 29, 1923. I have seen this patient lately. The tumor has not returned, and while he is working every day, he is rather weak.

It is interesting to note how long this man showed definite signs of pressure symptoms (twelve years) and how slowly the mediastinal shadow increased in size. The appearance of this area of increased density does not show the infiltrative appearance of a carcinoma, but a definite, smooth enlargement. His extreme asthenic condition gradually lessened after *x*-ray treatments were given. He now has the appearance of a perfectly healthy man with a normal endurance.

RESULTS WITH MODERN RADIOTHERAPY IN BLADDER TUMORS*

BY CHARLES GOOSMANN, M.D.

CINCINNATI, OHIO

IN checking up the results of the first year of high voltage roentgen treatment of bladder tumors, the 15 cases under treatment in that period (ending November, 1922) showed six failures and nine successful results. All cases in which the tumor was no longer visible on cystoscopic examination were counted successful, though some of these may show future recurrence. None of the tumors were submitted to microscopic examination. As Cabot says:[1] "There has been an interesting change of opinion regarding the relative frequency of benign and malignant papillomata. . . The trend of opinion, today, is unquestionably to consider as malignant the majority of papillomata, and that ultimately all papillomata tend to become malignant." And Keyes writes:[2] "Papilloma of the bladder is often a malignant growth, even when the microscope reveals no malignancy about it." All our cases were, therefore, considered at least potentially malignant.

RESULTS

The 15 patients are divided into three groups, according to the treatment: Group I includes 3 cases, all failures. All of these had roentgen treatment, but no radium, before coming to me.

Group II consists of 3 cases, with one success. Each of these had a preliminary suprapubic cystotomy. The successful case had the tumors cauterized through the bladder opening. Of the two failures one had radium tubes inserted in the bladder and the other had radium needles embedded in the tumor at the trigone.

Group three contains 9 cases with one failure. All of these had what I would call the preferred treatment—high voltage roentgen rays, combined with radium, as described under technique. Three of the 8 successful cases in this group had fulguration treatment after radiotherapy. One of them undoubtedly needed the fulguration, as the tumors were not gone after two courses of radiotherapy. The other 2 had only one course of radiotherapy; and in one of them, at least, the improvement was so marked that the tumor would probably have disappeared completely after another similar treatment.[1]

One of the successful cases of this group was still bleeding six weeks after treatment. The tumor was only slightly smaller. As the patient was unusually large, she was given another series, consisting of two hours' anterior and ninety minutes' posterior treatment. This caused severe reaction on the abdomen, but the bladder symptoms cleared up and the cystoscopic report was still good ten months after the last treatment.

---

[1] CABOT, H. Modern Urology. Philadelphia, 1918, ii, 198.

[2] KEYES, E. L. Urology. New York, 1917, p. 495.

[1] This patient has had a recurrence in spite of numerous fulguration treatments; and received a second course of radiotherapy in May, 1922.

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

TECHNIQUE

Simpson,[1] in discussing the treatment of cancer of the bladder, says: "It is worse than useless to apply radium blindly by means of an ordinary rubber catheter to the interior of the bladder." He advises direct application to the tumor through the urethra or a suprapubic opening. He does not use the roentgen rays.

Cabot,[2] believes: "It is now definitely settled that the endovesical method (fulguration or radium) is the treatment of choice for all papillomata, single or multiple, benign or malignant, and that suprapubic attack is only justifiable in exceptional cases."

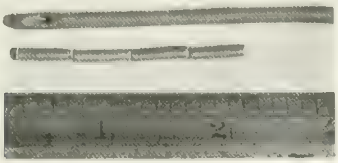


FIG. 1. Four radium tubes and catheter for insertion into the bladder.

I feel that bladder tumors are best treated by a method that reaches every spot of the bladder and the surrounding pelvis, with the largest radiation dose that can safely be administered. This requires the use of radium and roentgen rays in combination. The radium applicator for the bladder consists of four steel tubes containing a total of 51.3 mg. radium element. These tubes are each 12.5 mm. long and have a wall thickness of 1 mm. The four tubes are inserted, without further filtration, in a soft rubber catheter, No. 12 or 14 French. The catheter must be very elastic—I use the Eynard brand (model of Dr. Wishard).

This is inserted into the bladder and left in for six or eight hours, which may require several insertions. I have given twelve hours in one case without damage. The patient is instructed to turn on his sides, back and abdomen at hourly intervals, to distribute the action. The use of four tubes gives a long source of radiation, so the distant effect is improved, as compared with a point source of radiation, where the law of inverse squares applies.

For cross-fire nine standard steel radium needles of 10 mg. each are used in three brass screens, which are placed tandem in a rubber tube; this is inserted in a large rubber tube having an outside diameter of 18 mm. With a finger cot over the end, this applicator is inserted in the rectum and left in from four to six hours.

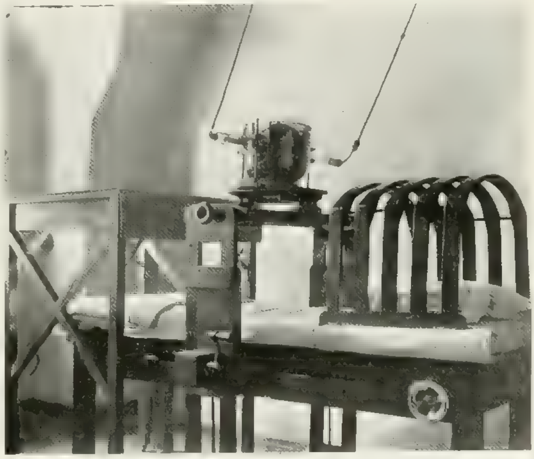


FIG. 2. High-voltage treatment table showing the cradle at the right, and high table at the left, for holding the protecting lead rubber above the patient. Two small strips, only, are placed directly upon the patient.

In women I also give a vaginal radium treatment.

The roentgen treatment is given at 200,000 volts, with 0.5 mm. Cu. and 1.0 mm. Al. filtration, and 20-in. target distance. At 4 ma. a total of three hours is given in the average case, equally divided between the anterior and posterior aspects of the pelvis. A leaded rubber strip is placed below the pubes and another about 10 in. above and the entire pelvis exposed between these two.

---

[1] SIMPSON, F. E. Radium Therapy. St. Louis, 1922, p. 211.

[2] CABOT, H. Modern Urology. Philadelphia, 1918, ii, 238.

In a heavy patient a slightly longer exposure is given, by additional anterior treatment.

A second course of treatment is given six to ten weeks afterward, if necessary, and the dosage is varied according to the amount of reaction produced. Epilation and erythema are considered necessary for the best results. If two series of radiations do not cause complete disappearance of the tumor, fulguration is advised. Geraghty[1] found that "some papillary tumors which seemed extremely resistant to fulguration treatment responded very promptly after a small amount of radiation. Consequently it has been a habit in our clinic to radiate most tumors, even those which subsequently will be treated by fulguration."

CONCLUSIONS

The best treatment of bladder tumors is a combination of radium and high voltage roentgen rays. I fully agree with Jenkinson, of Chicago, that "some of our best results with the deep roentgen therapy have been in urinary bladder tumors."

A CASE OF TUBERCULOSIS OF THE SYMPHYSIS PUBIS

BY J. B. JACKSON, M.D.

KALAMAZOO, MICHIGAN

DISEASE of the symphysis pubis appears to be relatively very rare. Obstetricians refer to an occasional septic process in this joint following trauma during labor. On account of the structure of the joint it is comparatively free from the acute infections.

The symphysis pubis belongs to the type of articulating surface known as amphiarthrosis. This type of articulation admits of a very limited range of movement. The joint contains no true synovial membrane. The articular surfaces of the pubic bones are covered with a thin layer of hyaline cartilage. Between these lies a disc of cartilage and fibrocartilage. The joint is securely held on all sides by ligamentous bands. The anterior and the sub-pubic ligaments are the more important of these structures. The joint structure is similar to the sacroiliac joint and to the articulation between the vertebrae.

Tuberculosis of the spine is a comparatively frequent manifestation of tuberculosis. Tuberculosis of the sacroiliac joint is observed infrequently. Tuberculosis of the symphysis pubis seems to be a very rare disease. A review of the literature brings out the fact that before the general use of the *x*-ray the diagnosis was extremely difficult. We have been unable to find any report of tuberculosis of the symphysis pubis in English, although the possibility of its occurrence is mentioned briefly by various authors.

The condition was apparently first described by Hennies in 1888. He reported 3 cases, 1 male and 2 female. They were all treated surgically and all recovered. He states that the pain in this disease is easily mistaken for neuralgia and the tumor for hernia or a psoas abscess.

In 1890 Chauvel reported one case of a man aged twenty-three. In this case almost the total of the symphysis pubis was involved and necrotic and was removed in the form of sequestra.

Von Bungner in 1899 reported a case in a woman aged fifty-seven. This case was treated surgically and recovered. He refers to the danger of mistaking the abscess for inguinal hernia. He states that the prognosis depends upon tuberculous lesions elsewhere in the body and on the use of early radical surgical treatment.

In 1902 Herz reported 2 cases. In this article he states that Krause has briefly mentioned 2 cases. Herz's 2 cases were males aged eighteen and fifteen. Both were treated surgically. One died. This death was attributed to the fact that the patient would not consent to the operation until extensive destructive processes had taken place. The other made a good recovery. He mentions difficulty in walking as an early symptom. Krause noticed in his 2 cases an abnormal motility of the pelvic bones.

---

[1] Geraghty, J. T., Treatment of malignant disease of the prostate and bladder. *J. Urol.*, January, 1922, vii, No. 1, p. 46.

Tillman in 1905 writes of the rare occurrence of tuberculosis of the symphysis pubis. In addition to the cases already mentioned in this review he mentions a case reported by Motz in 1890. Tillman refers to the formation of cold abscesses above and behind the symphysis. Pus may collect in the inguinal region. Fistulae usually occur above the horizontal ramus on one or both sides; more seldom in the middle or both sides of the labia majora or scrotum or on the inner side of the thigh below Poupart's ligament. He speaks of disturbance in the gait as an early symptom. According to this author, prompt and early surgical treatment is the only treatment worthy of consideration.

Woloch in 1907 reports in detail a case in a woman of sixty-three who finally recovered following extensive surgical treatment. He states that because of the paucity and indefinite character of the symptoms the cases are seldom diagnosed until the appearance of fistulae. He mentions the possibility of involvement of the hip by extension along the pelvic ramus and the perforation of the bladder by the abscess.

Bungner in 1914 reported a case in a woman of fifty-seven treated successfully by surgery. He considered the disease more common in women than in men. In all cases described suppuration has occurred. Dry caries has not been described.

Rendu and Wertheimer in 1922 reported a case of tuberculosis of the pubis and symphysis in a boy aged nine. There was a fluctuation over the internal part of the right thigh. Radiography showed a bone lesion in the descending branch of pubis at angle of pubis. At operation the symphysis was found involved. There was complete recovery following curettage.

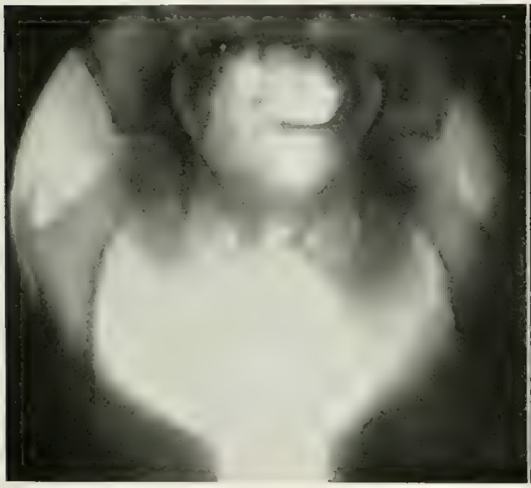


Fig. 1. Apr. 10, 1922.

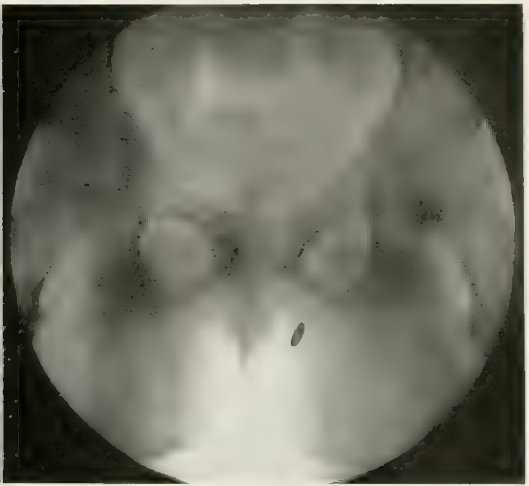


Fig. 2. Jan. 13, 1923.

During the present year (1923) Swynghedauw and Druon have published a paper on this subject. They state that tuberculosis in the pubis is particularly insidious and is only revealed by fistulae generally appearing considerably distant from the affected spot. In the majority of cases the diagnosis was for a long time erroneous; and by radiology alone was the true condition revealed. They state that in 1916 Bessett collected 56 cases, but that several of these were not truly cases of tuberculous osteoarthritis. They mention 9 cases since that date and 1 case seen by themselves. Pregnancy and labor are undoubtedly factors in several cases. Under the influence of labor a previously latent lesion becomes acute and in several cases has led to the patient's death. However, the disease is slightly more frequent in males. They refer to Labeyre's description of a periostitis of the pubic region characterized by a thickening and caseous transformation of the periosteum. This type has a tendency to invade the angle of the pubis and spread to the symphysis, the cartilage of which ulcerates, softens and then peels away; fungosities are soon substituted for cartilage, the ligaments are resorbed and the symphysis stripped of all means of contention and destined to rupture on the least effort.

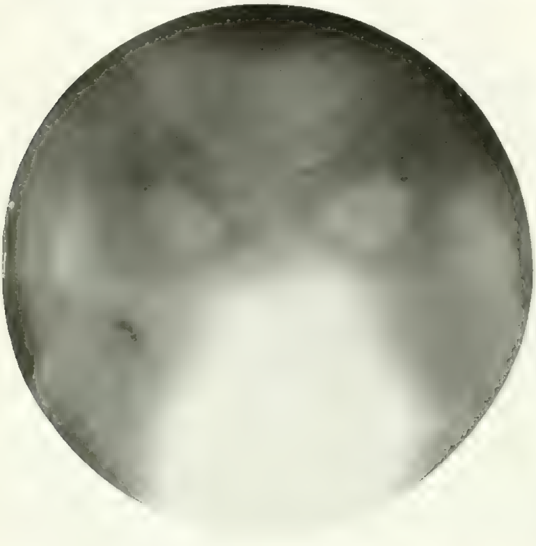


Fig. 3. Mar. 23, 1923.

Surgery is especially valuable in the treatment because of the fact that the symphysis pubis is superficial and easily accessible. These authors think, however, that in early cases without pain, suppuration or sequestra, operation is not justified, and that such cases only call for the general treatment of tuberculous osteoarthritic lesions.

We should like to report the following case in which the diagnosis was made in the course of a roentgenological examination of the lumbar spine:

The patient is a girl who was first seen in February, 1922. She was at the time eleven years old. She had never been robust. She had had measles, chickenpox and a severe attack of whooping-cough. Two years previous she had had influenza followed by pneumonia. About a year ago she had a severe colitis which lasted about ten days. There is no family history of tuberculosis. The father and mother are living and well. She has a brother about a year younger who is described as "frail."

A few weeks before she was first seen by us, the family had noticed something unusual about the gait. There was difficulty about walking fast or running. Soon after this a swelling was noticed on the anterior surface of the right thigh immediately below Poupart's ligament. At this time she was brought for *x*-ray examination of the spine where the abscess was supposed to have originated.

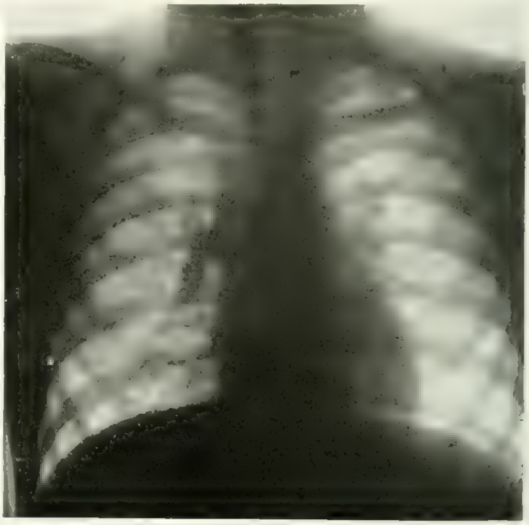


Fig. 4. Mar. 23, 1923.

The *x*-ray examination of the spine showed no evidence of vertebral disease. On the films made of the lower spine there was observed a destructive lesion of the pubic bones at the symphysis pubis. This first called attention to the symphysis pubis as the site of the lesion. Further *x*-ray study was then made of this region. The cold abscess was aspirated. About one and one-half ounces of a thick, creamy, greenish pus was withdrawn. Cultures made from this were sterile. A guinea-pig inoculation with the pus resulted in an extensive tuberculous infection at the end of twenty days.

A set of stereoscopic plates was made on April 10, 1922, with the patient in the prone position. There is a honeycombed appearance of the body of the pubis on the right side which extends well into the horizontal branch of the pubis and down to the lower border of the symphysis. On the left side there is also a honeycombed appearance of the body of the pubis, much less extensive than on the right. There is apparently some separation of the two pubic bones. No thickening of the periosteum can be made out, the bone lesion being apparently a destructive process with no tendency to production of new bone.

Another set of stereoscopic plates was made on January 13, 1923, with the patient in the prone position. The lesion has apparently been somewhat progressive. The honeycombed appearance on the right side extends slightly further back. There is very much less bone detail to be seen at the site of the lesion. The fine reticula of bone seen in the first plates have apparently been destroyed by the progress of the disease. The destructive process on the right side is considerably more extensive than that on the left. At one point near the lower border of the body of the pubis the obturator foramen is nearly broken through. There is still no evidence of bone proliferation.

The last set of stereoscopic plates was made on March 23, 1923. There is apparently no further extension of the disease. There has been further destruction of the bone, so that there is almost no bone detail to be seen between what is left of the two pubic bones. The diseased bone apparently has been gradually destroyed, but there has been no appreciable advance in the extent of the lesion.

On March 23, 1923, a set of stereoscopic plates was made of the chest with the patient in the prone position during full inspiration. The shadow of the heart and great vessels is normal. There is no fluid in either pleural cavity. The costophrenic angle is normal on each side. There is apparently no thickening of the pleura over the apex of either lung. The hilus shadows are rather large and nebulous and show very little tendency to calcification. From the right hilus extending up toward the first and second interspaces in front are very dense peribronchial lines which lead to the periphery of the lung. On the right side there is some peribronchial thickening extending up toward the apex and the first intercostal spaces. The peribronchial lines on the left side are less dense than on the right. The thickened bundles of peribronchial lines seen extending from the right hilus towards the first and second interspaces very strongly suggest old pulmonary infection.

The treatment carried out by the child's father, a physician, has been non-surgical. The child has not been allowed to walk. No immobilization apparatus has been applied. Especial attention has been given to nutrition, fresh air and sunshine. Of late, exposure to direct sunlight has been used.

She was last seen by us in March, 1923. The cold abscess refilled slightly after aspiration but there was a very little swelling when she was last seen. There has never been a discharging sinus. The temperature has shown very little tendency to elevation. She has gained several pounds in weight and feels perfectly well.

The infrequency of this condition has seemed to warrant our report of this case. It is too early to judge of the result of treatment, but the case seems to be doing fairly well. We are mainly interested in the *x*-ray study of the case and wish particularly to call attention to the possibility of tuberculous caries of the symphysis pubis when searching for the origin of cold abscesses or fistulae in the region of the pelvis.

BIBLIOGRAPHY

1. Hennies, Ernst. Zur Kenntnis der Fälle von tuberkuloser Caries der Symphyse auf Grund klinischer Beobachtung. Inaugural-Dissertation, Greifswald, 1888.
2. Chauvel. Osteite tuberculeuse du pubis. Ablation de la moite gauche de la symphyse. Guerison. *Bull. Soc. de chir.*, Paris, 1890, xvi, 430.
3. Von Bungner, O. Ueber die Tuberculose der Symphysis ossium pubis. *Arch. f. klin. Chir.*, 1899, lix, 892.
4. Herz, P. Die Tuberculose der Schambein-symphyse. *Deutsche Ztschr. f. chir.*, Leipz., 1902, xix, 307.
5. Tillmann, H. Tuberkulose der Symphysis Ossium Pubis. *Deutsche. Chir. Lief*, 1905, lxii, 422.
6. Woloch, Salomon. Ein Beitrag zur Tuberkulose der Symphysis ossium pubis. Inaugural-Dissertation, Basel, 1907.
7. Bungner. Sobre la tuberculosis de la sinfises pubiana. *Clin. mod.*, 1914, xiii, 143.
8. Rendu, A., and Wartheimer, P. A case of tuberculosis of the pubis and of the symphysis pubis. *Rev. d'orthop.*, 1922, xxix, 363.
9. Swynghedauw and Druon. Tuberculosis of the angle of the pubis and of the symphysis pubis. *Gaz. d. hôp.*, Paris, 1923, xcvi, 413.

ROENTGEN THERAPY OF CHRONIC PROSTATIC HYPERTROPHY*

BY J. THOMPSON STEVENS, M.D.

MONTCLAIR, NEW JERSEY

IN Cunningham's Anatomy one can find the following statements: "In old age the prostate frequently undergoes an hypertrophy which may affect chiefly the glandular tissue, or the entire organ. Not infrequently calcareous concretions are found imbedded in the prostate. In old people the veins of the prostatic plexus usually become much enlarged." Add to the above the chronic, passive inflammation that is present in many of the cases of prostatic hypertrophy and we have the complete pathology or the physiologic pathology of the usual case of simple enlargement of the prostate gland.[1]

We have for years known that glandular tissue is the easiest normal tissue of the body to destroy by means of the roentgen rays or by radium rays. For example, when raying about the mouth, the operator is often greatly annoyed by the complaints of dryness of the mouth and throat. This complaint is due to the radiation which is sent into the depth of the salivary glands. Under proper methods of technique this complaint is only temporary, but with greater dosage would become permanent because the salivary glands would be destroyed. Again when raying the depths in the region of the suprarenal capsules, it is, I believe, good technique to give the heaviest doses of rays from the front with lighter doses from the back and sides, also to prescribe feeding of suprarenal substance to overcome the untoward effect of the rays upon the suprarenal capsules.

It is a proven fact that radiations in proper amounts will cause endarteritis and phlebitis resulting in a reduction in the size of the arteries and veins, thereby causing a reduction in the amount of blood entering and leaving the region that has been radiated. Continued radiation would eventually cause an obliterative endarteritis and phlebitis. For example, I will just mention the promptness with which uterine bleeding stops under treatment by means of radiation therapy, whether the hemorrhage is due to carcinoma, to fibroid, or is idiopathic.

From what has already been said about the pathology or the physiological pathology as encountered in the usual case of simple hypertrophy of the prostate gland, that is the hyperplasia of the glandular elements, the enlargement of the veins of the prostatic plexus, and the chronic inflammation, one must admit the possibilities for treatment by means of radiation therapy.

The results following roentgen therapy in chronic prostatic hypertrophy have been so uniformly good that I feel justified in presenting these few cases for your consideration.

Up to the period ending July 31, 1922, 33 cases of hypertrophy of the prostate gland have been treated. No case was refused treatment and every means was exhausted to make the best possible diagnosis. In each instance the diagnosis was made by a medical man or surgeon in addition to my own studies. Out of the total of 33 cases there were 9 catheter patients, 24 who complained of one or more of such symptoms as frequent micturition; urgent, painful urination; nocturnal, frequent urination; hematuria; pain in the perineum; strong-smelling urine etc., and who upon examination showed a definite tumor in the prostatic field and residual urine. The tumors varied in size and were generally about as large as would be expected with the symptoms presented by each patient. The largest gland felt very much like the head of a child presenting at term. It was in this case that we obtained one of our best results, the details of which are given below, in fact the gland was so large that the patient, in addition to having to use the catheter, was beginning to have considerable trouble in emptying his bowels. Out of the 33 cases we have to date one failure and two deaths. The failure was in one of the catheter cases who presented one of the largest prostatic tumors that was treated. This case too, I have cited in detail below. Death was due in one case to cerebral hemorrhage and in the other to cardiac failure. In 30 out of the 33 cases our treatment met with success, i.e. the retention was relieved, likewise the frequency, the urgent, painful urination, the bleeding, the pain in the perineum etc.; and upon examination it was found that in 3 of the cases the gland had returned to normal size, and that in 27 cases it was reduced on an average to one-third its size as determined in the beginning, and instead of being hard, was soft to the touch.

---

[1] STERN, SAMUEL. *X*-ray treatment of hypertrophy of the prostate. AM. J. ROENTGENOL., June, 1921, viii, 292.

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

Case I. Male, a patient of Dr. T. Paczkowski, aged sixty-two, unemployed; sent for treatment Sept. 7, 1920. For a considerable period of time he had complained of frequent, urgent micturition. At night he would commonly try to pass his urine about every ten minutes. For the past two months he has been unable to pass any urine at all unaided, and required catheterization twice daily. Lately he has noticed a sensation of weight in the perineum and it is becoming quite difficult for him to have a satisfactory stool.

Examination shows an old man upon whose face there are unmistakable signs of pain and misery. A metal catheter brought away one and one-half quarts of urine. (I was unable to get the usual soft rubber catheter into the bladder.) Rectal examination shows a mass in the prostatic field which feels much like a presenting vertex at term. The mass appears to be symmetrical and is very hard and tender. General physical condition of patient is excellent.

Treatment. Eight areas for application of the roentgen rays were used, four just above the symphysis pubis, two over the gluteal muscles to the right and left of the anus. Over each area the rays were centered toward the prostatic field. Factors for treatment were: 5 ma., 133,000 volts crest value, 8-in. focal distance, 6 mm. aluminum filter, and time sufficient to give 4/5 of an erythema dose over each area. Time will vary with different machines—in fact it varies in my office between two machines of exactly the same construction. These treatments were repeated in October and November for prophylaxis.

Results. The third day following our first treatments the patient emptied his own bladder and has not had to be catheterized since. One week after treatment there was a bloody discharge from the bladder together with many small stones. Bleeding and passage of stones has to date been present but once as just outlined. Rectal examination two months after treatment was completed showed a total absence of any tumor in the prostatic field. Upon inquiry through Dr. Paczkowski, I find that there has been no recurrence of any bladder symptoms. Our patient has been well for two years and four months since treatment was started by means of the roentgen rays.

Case II. Male, a patient of Drs. W. E. Doremus and J. G. Cottrell, aged seventy-three sent for treatment March 14, 1922, with complaints of dribbling and frequency which had been present for the previous four or five years. The frequency was most marked at night and in the winter. For the three weeks before he was referred to me, he had been unable to empty his bladder except by catheter. Ten days before the catheter had to be used, there was an attack of bronchopneumonia.

Examination shows a weak, tottering old man hardly able to walk unaided. The prostate is large and soft. Dr. Doremus once found the upper border of the bladder on a level with the umbilicus. Catheter brought forth purulent urine. Phenolsulphonephthalein test gave a 10 per cent total for two hours.

Treatment. Four areas were selected for the application of the roengen rays, two over the symphysis pubis and one to the right and left of the anus over the gluteal muscles. Over each area the rays were centered toward the prostatic field. Factors for treatment were: 5 ma., 133,000 volts crest value, 16-in. focal distance, 6 mm. aluminum filter, and time sufficient to give 4/5 of a full dose over each area. These treatments were repeated on March 30, 1922 and April 14, 1922.

Results. During our treatments the patient became able to empty his bladder once daily when on his back. He had to be catheterized once daily and was unable to pass any urine when standing. Why this should be so, I am sure I do not know. There was marked improvement in the patient's general condition, and he walked alone with a quicker, firmer step. In any event our treatment failed to eliminate the use of the catheter and in no way relieved the desire to urinate. On June 19, 1922, Dr. Doremus found that the phenolsulphonephthalein test now gave a total excretion of 50 per cent, that is, nearly a normal result. This with other findings led to a decision to remove the gland surgically.

Operation. Suprapubic removal. June 23, 1922. Dr. Doremus reports that the gland was removed with very little loss of blood, and the surgical difficulties were no greater in this case than in others, which had not been treated preoperatively by radiation therapy. Operation was followed by an attack of bronchopneumonia, and during a spasm of coughing the suture line burst open. Then followed a hernia of the peritoneal pouch and bladder wall through the opened suture line. Under local anesthesia, on Nov. 28, 1922, the redundant or excess membrane was removed and the skin closed with a good result except that there is still a draining suprapubic fistula of pin-point size. A No. 26 sound drops into the bladder, thereby eliminating any uretheral obstruction which might keep up the drainage.

Results. Ever since the prostate was surgically removed the patient has been able to pass his urine freely and the general health is excellent.

Laboratory Findings. Whole gland was removed and weighs 52½ gr. Section shows several cysts filled with a thick greenish material. Fibrosis very well marked. The microscope shows glandular elements markedly increased, stroma shows increased fibro-elastic tissue. Diagnosis: Adenoma with fibrosis. No evidence of malignancy.

Remarks. The reason why we failed to produce the desired results by means of radiation therapy in this case, is evident to every radiotherapist. None of us treat cystic goiter, because our treatment accomplishes nothing. Cystic goiter is usually easy to diagnose, but I know of no method of examination that will diagnose a cystic prostate in the living patient. Also we are unable to influence fibrous tissue without destroying surrounding normal tissue. In other words, I shall always believe that this case was a failure because of the cystic disease with fibrosis.

TABLE

	Total No. of patients treated	No. of successes	No. of failures	Percentage of successes	Deaths	Percentage of deaths
Catheter patients	9	8	1	89	0	0
Patients with bladder symptoms, enlarged prostate, and residual urine. . .	24	22	0	92	2	8

CONCLUSIONS

1. If the results obtained in this series of cases can be produced in the majority of cases that present themselves for treatment in the future, the treatment of simple hypertrophy of the prostate gland by means of radiation therapy is justifiable. These old, debilitated men will appreciate this method of treatment.

2. In proper hands the treatment is free from danger.

3. There is no loss of voluntary control of the bladder, likewise the rectum is not injured, there is no persistent urinary fistula, and complicating conditions are usually no contraindication to radiation therapy. The treatments are given without shock, hemorrhage, uremia, bronchitis, septicemia, pulmonary embolism, etc., and there is no mortality that can be traced to the treatments for a cause.

4. Should treatment by means of radiation therapy fail, surgery can be substituted. Radiation does not produce any condition which interferes with surgical removal of the gland. In fact, in our one case, following radiation the gland was removed with much less hemorrhage and without more surgical difficulty than had the patient not been radiated.

DISCUSSION

DR. PFAHLER. I believe myself that this is a field that has been very much neglected. I have not treated many cases, but at least the patients whom I have treated have improved symptomatically in all cases. Perhaps it was the natural course of events.

Originally I carried out a technique very much like that used by Dr. Stevens, but I do not believe it is a technique we will follow in the future when we do treat these patients. I think we will treat at long distances and probably confine the treatment to the perineal region. We need never go to the extent of damaging the skin.

Some of you may know that I am treating with high voltage with the tube under a 16-in. concrete floor, and therefore I have considerable distance even to start with, and the closest I get to the patient is 62 cm. I have constructed a special chair to fit on the floor so that the patient sits rather comfortably on the floor and the rays are sent up through the perineal region and are confined to the region of the prostate. My aim has been, with the high voltage and highly filtered rays, to give about 50 per cent of an erythema dose and repeat it perhaps once a month. In that way is brought about a progressive but positive atrophy. It may be just the natural course of events.

Dr. Stern. Unfortunately I did not hear all of Dr. Stevens' paper. The part I heard dealt with his technique and his final results, and it gave me a great deal of pleasure to hear of them.

Some years ago I read a paper at one of these meetings here on the *x*-ray treatment of hypertrophy of the prostate. At that time I quoted 6 or 8 cases that were very much improved. These patients have all kept well and in not a single case has surgical interference become necessary. Since that time I have treated quite a number of others and the results in most of these cases were very gratifying. I have not been able to do much for patients who have already entered the catheter life. They reach a point of improvement where most of their subjective symptoms are improved, but they still have to keep on using the catheter. I think this is due either to a mental hazard on their part, that is, they just feel that they cannot voluntarily void, or there is a paralysis of the sphincter through disuse, which makes it impossible for them to regain control.

My technique seems to differ from Dr. Stevens'. I do not treat them through the symphysis, for the simple reason that working with a low voltage and 6 mm. Al. filter, there is a long distance to travel to reach the prostate and the depth dose from an exposure given this way is rather small. When I was abroad I found that they were treating these cases with high-voltage intensive treatments. In one case in which I tried this, the treatment produced considerable tenesmus of the bladder and made the patient so uncomfortable that I decided to continue with my low-voltage fractional treatment. With my technique I use the rectum and the perineum as my ports of entry. I give them one-half of the erythema dose filtered through 4 mm. Al. once a week through the rectum and through the perineum. Four of these treatments constitute one series. Treatment is repeated at the end of a month's interval and again after an interval of one or two months following this. Cases that have a cystitis must be treated for this separately in the usual way. The symptoms of hypertrophy of the prostate and cystitis are so similar that no matter how much we improve the condition of the prostate, with a persistent cystitis, we still get practically the same symptoms as we did before. The treatment is so simple and the majority of these patients do so well that I see no reason why it should not be tried on all prostatics before surgical interference is advised. The amount of ray that they receive would not in any way interfere with carrying out surgical measures if the treatment should fail.

These cases, a great many of them, if referred to us in their earlier stages, I have no doubt would be saved an operation.

Dr. Hunter. In 1911 I presented a paper on this subject at the Richmond meeting of the American Roentgen Ray Society. I thought I got some fair results.

I would like to ask Dr. Stevens one or two questions: I used to treat these cases in the Sims position and treat through the perineum. I had a feeling at that time that application of rays against the scrotum did have some effect: perhaps I was influenced by the surgical opinion in which a double orchidectomy was considered as helping prostatic conditions.

I feel now that with the filter and long distance we should accomplish a great deal. Just after my paper the two-stage operation for prostate was introduced and the result was that the surgical mortality fell to its present rate.

I would like to ask Dr. Stevens what he thinks of treating through the perineum, especially with the new technique and using a rather large area, and whether he thinks direct application of ray to the scrotum has any advantage at all.

Dr. Stevens (closing discussion). In 3 of the cases in our series the prostate was reduced in size enough to give no residual urine. In the others, the average amount of residual urine remaining after treatment was about one-third of that before treatment. The first case reported above in detail was the most striking result obtained in many respects. This was the only case in the entire series suitable for surgery. The others were in such condition that surgery could never have been instituted with any hope of their living through the operation.

The pathology of the usual case of prostatic hypertrophy would naturally lead the radiotherapist to the conclusion that such cases belonged to him. Surely if he had a disease with chronic inflammation, with enlargement of veins, or with hyperplasia of glandular elements, he would be justified in expecting his treatment to produce nearly perfect results.

I am rather disappointed in what Dr. Stern had to say about the treatment in Germany with the higher voltage rays. Having been equipped with the necessary apparatus for higher voltage work in 1922, I had hoped to be able to work out a definite therapeutic dosage for the treatment of hypertrophy of the prostate. Dr. Stern's discussion, I feel, answers Dr. Pfahler's discussion. Dr. Pfahler apparently was looking hopefully to the higher voltage rays to produce even better results in the future. I am of the same opinion regarding the higher voltage rays. Before we can speak with authority they must be tried out extensively by several of us.

In reference to surgery after radiation, in the one case I reported in detail which did have surgery, the surgeon said that the operation was done with very little bleeding, also that the difficulties of surgical removal of the gland were not increased.

Dr. Hunter's work with no filter must have been done long ago when little was known of the proper methods of getting high intensity depth doses. With no filter we would get a high dose of rays on the skin very quickly with little or no depth intensity, therefore without beneficial results. I have had no experience in the treatment of this condition by exposure of the testicles. I have always been very careful to see that they were not exposed to the rays.

ROENTGEN-RAY TREATMENT OF THE THYROID

BY E. L. JENKINSON, M.D.

St. Luke's Hospital

CHICAGO, ILLINOIS

DURING the past five years roentgenotherapy in the management of toxic thyroids has been steadily gaining recognition. There are certain cases which are definitely surgical, and others which are just as definitely cases for the internist and roentgenologist. Experience has taught us that the colloid, cystic and simple goiters with no toxic manifestations are not suitable cases for roentgenotherapy. Thyroids causing pressure symptoms are definitely surgical. Toxic adenomata should always be given the benefit of *x*-ray therapy before being subjected to surgery. If, after careful and proper treatment, the *x*-rays fail to produce a marked improvement, surgery may be resorted to. The number of failures, however, under roentgenotherapy, if properly administered, will be small.

The question of adhesions following *x*-ray therapy is often raised by surgeons. Some surgeons claim that following its use, operation becomes very difficult, due to the large amount of hemorrhage and connective tissue encountered. On direct inquiry, the majority of surgeons questioned have stated that they experienced no great difficulty in removing the gland. One case is illustrative: a woman of twenty-four, suffering from an exophthalmic goiter, had been given six series of *x*-rays and her condition did not improve as rapidly as the internist had anticipated. The patient being a working-girl, and time being an important factor in her treatment, it was thought advisable to resort to surgery. The operation was comparatively simple, for the gland was removed without any difficulty. No increase in connective tissue was found, and there was no increase in the amount of hemorrhage

Physicians using roentgen therapy in the treatment of toxic thyroids are often asked: What are you using on your thyroids? What voltage? What filter? What milliamperage? etc. After treating and watching about 300 cases, we are convinced that the administration of the *x*-rays must be according to the individual case. Its use as a therapeutic agent must not be a fixed quantity from which no deviation shall be made. It is a matter of judgment and cannot be made to conform to a simple rule of thumb. A thorough physical examination is indispensable, the heart and nervous system being closely scrutinized. Rest in bed is imperative, before and after treatment, preferably in a hospital. The patient must be made as comfortable as possible. The nurse caring for the patient should at all times be agreeable, for these patients are very irritable and easily upset. Each time the patient becomes nervous and irritable, a definite setback is the result. The food should be very nourishing and easily digested. Drugs may also be used in conjunction with the *x*-rays; the bromides have a tendency to lessen the nervousness. An ice bag to the precordia, in some cases, is helpful. During the series of treatments the bowels should be regulated by the use of bland cathartics or an occasional enema.

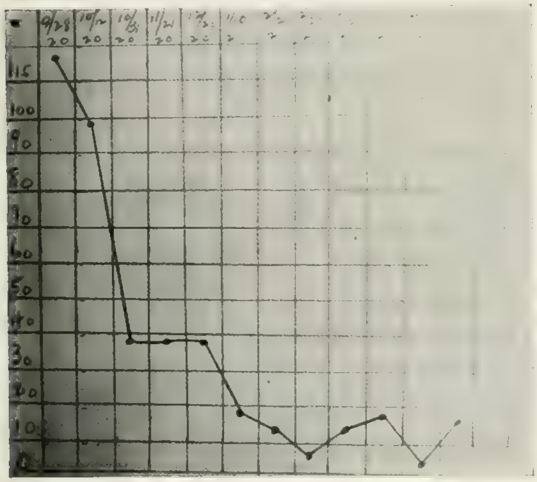


FIG. 1. Case 1. Five series of *x*-rays. Gained 55 lbs. Symptom-free.

For radiation sickness, which sometimes occurs, one dram of sodium bicarbonate in cold water may be given three times a day. A good plan is to put the patient on bicarbonate of soda two days before starting the treatment, continuing through the series.

The treatment room should be very quiet and well ventilated. The use of electric fans tends to keep up a good circulation of air, lessening the chance of radiation sickness. The transformer should, whenever possible, be in a sound-proof room. The testing of the machine, obtaining the spark-gap and milliamperage should be done before the patient arrives. All unnecessary noises and handling should be avoided. All patients should be transported to and from the treatment room on a stretcher. If the above details are complied with, the amount of nervous reaction is lessened. During treatment, the patient should be made comfortable, assuring her that she will experience no pain. She should be instructed that quiet is necessary during the exposure, and that the procedure is devoid of any danger.

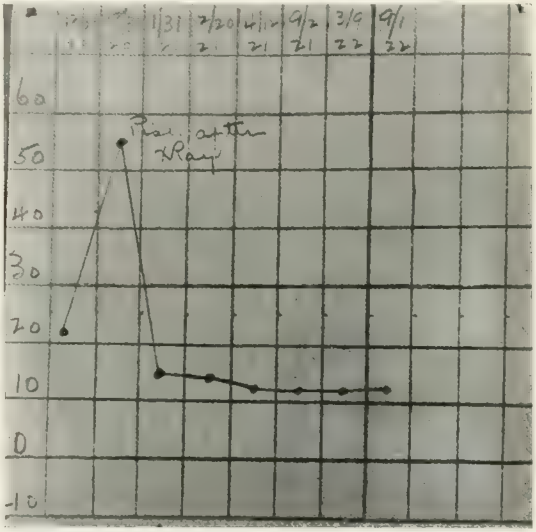


FIG. 2. Case 2. One series of *x*-rays. Recovery complete.

After a careful consideration of the individual patient, the size of the dose is estimated. If the patient is very toxic and shows a greatly increased metabolic rate, one treatment is given over the thymus anteriorly. The patient is then allowed to rest for a day before administering another treatment, and the effects of the treatment are observed. Subsequent dosage should be modified according to the reaction experienced after the first treatment. There is no particular hurry in giving the treatments; in fact, the patient will usually do better if kept in the hospital a week for the series.

In treating goiters, three areas are given through portals 4 × 4 in. The thymus is rayed anteriorly in all cases. The thyroid is treated through two portals, one to each lobe. The larynx is carefully protected during treatment. In no case is an attempt made to obtain a skin reaction. If an erythema, or even repeated tannings are obtained, a subsequent telangiectasis is apt to occur.

In all cases a comparatively heavy filter of 6 mm. of aluminum is used. A 12-in. focal skin distance is a constant factor, also 5 ma. The voltage in all cases is 125,000 peak, or the equivalent of a 9-in. spark-gap between points. The time is the variable factor and is changed to suit each case.

Following the treatment, in the course of twelve hours, the thyroid may show a marked enlargement. The patient or relatives may call you, complaining of the swelling of the neck; you can assure them that nothing serious will follow and that in another twelve hours the swelling will have subsided.

For the past eighteen months, a basal metabolism has been determined on all cases prior to treatment, and repeated following it; this has lessened the chance of going too far in the treatment, producing a hypothyroidism. Before a second series of treatment is administered, the patient is instructed to return for a physical examination and a determination of the metabolic rate.

It has been our policy not to treat a patient after the metabolic rate has dropped to +15. A few cases have been treated when the metabolic rate had reached a slightly lower level, but never when lower than +10.

The clinical manifestations usually coincide with the metabolic rate. Patients having a metabolic rate of +80 to +90 should by no means be subjected to the same treatment as patients with a +30.

The dose of the *x*-rays indicated in each case is decidedly different. If a patient with a metabolic rate of +90 were given the same dose as the patient with a metabolic rate of +40, the results would, in a great many instances, be unfavorable.

The heart action in many cases becomes more rapid; nausea, vomiting, severe headache, and occasionally collapse, follows. Delirium was observed in three cases.

The above observations are mentioned to emphasize one point: *Treat the individual case.*

Many cases, showing some of the symptoms of a toxic goiter, are referred to our department for *x*-ray therapy. These patients are subjected to a metabolic test before deciding upon the type of treatment to be followed. Frequently the metabolic rate is found to be normal. Such cases are always re-examined to rule out any error in the determination. If, after the second examination, the results are the same, the patient is not radiated but carefully watched, and the test repeated at short intervals. Many cases showing symptoms similar to those encountered in hyperthyroidism are suffering from pathology located outside the gland. There are times when even a hyperthyroidism will show a comparatively low, or even normal metabolic rate. It will be observed, however, that during the period in which the metabolic rate is low, the symptoms will also have subsided. If these patients suffer an exacerbation, there will be a concomitant rise in the metabolic rate.

Criticism of the basal metabolism, belittling the method and attaching very little significance to its value, is in many instances unwarranted. If the test is made during a period when the patient is absolutely quiet, as the word "basal" implies, the results will be of great value in determining the severity of the disease. The fact that the test must be in some cases repeated before a definite rate can be established, does not in any way lessen its importance. We are all called upon, in many cases, to repeat physical examination of the heart and lungs, before arriving at a definite diagnosis. Even the surgeon must at times repeat the operation for hernia, before a cure can be obtained.

The close cooperation of the surgeon, internist and roentgenologist, similar to the plan adopted at the Massachusetts General, will certainly bring about a better understanding of the various methods of treatment, from which the general public will profit. It seems that we are all carrying a chip on our shoulder, each claiming that his method is the only one that will produce a cure. If we worked in harmony this feeling would not exist, and the results in many cases would show a higher percentage of cures. I am quite sure the *x*-ray will not cure all cases of hyperthyroidism, and I am also convinced that surgery has a certain number of failures.

In many localities, a compensatory hypertrophy of the gland is endemic. This is a physiological process and should not be interfered with. The presence of a rapid pulse or even of a tremor in such cases, is not conclusive evidence of an exophthalmic goiter or hyperthyroidism. We do not believe an exophthalmic goiter or hyperthyroidism is ever encountered with a metabolic rate constantly normal or below. In deciding these cases, the basal metabolic rate is of great value.

Approximately 100 cases have been checked immediately following radiation. In all of these there was a marked rise in the metabolic rate. The average rise was about twenty points. The cases showing the highest rates usually showed the largest increase; one patient, however, showing a low reading of +18, increased to +50 immediately following the series. Accompanying the rise of the metabolic rate, there is a proportional increase in the severity of the symptoms. We can see from the above findings that each case is a separate and distinct entity.

In the series of 300 cases the results have been uniformly good. With the exception of 2 patients, there has been a marked improvement in all cases. This does not mean, however, that all our patients were cured.

Two fatalities occurred in our series. At present, we do not feel competent to discuss the cause of death. Autopsies were not obtained in either case. The *x*-ray dosage in both cases was very small and distributed over a period of ten days for the one series. Both patients had been treated before, and nothing unusual was noted during the previous series.

In this series, one patient showed a metabolic rate of +150, accompanied by all the classical symptoms of a toxic thyroid. After four series, the recovery was complete, and during three years' observation there has been no return of symptoms. The metabolic rate has remained normal.

CONCLUSIONS

1. Not all types of goiter are amenable to *x*-ray therapy. The colloid, cystic and simple thyroids should not be subjected to radiation.
2. Each case should be treated as an entity. Routine treatment of all cases is unsatisfactory.
3. Frequent metabolic determination is an indispensable guide in the treatment of thyroids.
4. The majority of cases of hyperthyroidism and exophthalmic goiter will respond to *x*-ray therapy.

CLINICAL PROBLEMS IN ROENTGEN THERAPY OF DEEP-SEATED MALIGNANCY

BY CHAS. L. MARTIN, M.D., AND J. M. MARTIN, M.D.

Department of Roentgenology, Baylor Medical School

DALLAS, TEXAS

A PERUSAL of the current literature must undoubtedly lead the uninitiated to the conclusion that the application of the roentgen rays for therapeutic effect is now merely a problem in physics; that one need only apply a certain percentage of a given dose to a specified volume of tissue to produce good clinical results. Such a conclusion is, of course, a most erroneous one. Deep therapy, as the name implies, was elaborated in an effort to influence deep-seated malignant lesions, but the efficient treatment of such conditions means much more than the application of a calculated dose to the primary seat of the trouble. The patient coming to the radiologist for treatment is usually well beyond the early stages of his affliction and presents symptoms of a varied nature, based upon one of many intricate combinations of pathological lesions. He is, unfortunately, quite often sent to the roentgen laboratory only after all other methods have failed. Treatment should be planned to give symptomatic relief, especially where a complete cure is improbable. It is first necessary to take a careful history and carry out a most thorough and searching physical examination. The data obtained should be filed in permanent form in the laboratory, for without such data no intelligent idea of clinical progress is possible. Information obtained from careful examinations made at regular intervals following the irradiation should be filed in the same record. It may seem unnecessary to mention such examinations, and yet there are many laboratories in which they are not made, and many of the case records are extremely meager except as regards physical data. We have seen patients receive treatment in a cut and dried manner without the removal of any of the clothing, the plan of attack being a routine one for the diagnosis sent in.

Certain radiologists have contended that their patients should be examined by a clinical man because they themselves are not capable of making the necessary investigations. If these men would take up the study of the clinical course of malignant tumors and add the information gained to their extensive knowledge of the roentgenographic appearance of malignancy in the chest, bones, stomach, colon, kidneys, etc., they would be much better prepared to examine cases of malignancy than the average clinical man, who considers cancer as only one of the branches of his work. This paper is written in an effort to turn some of the energies of the roentgen therapist from the field of pure physics to the great realm of gross pathology and biological reactions; for after all, we are treating living patients and not tanks of water having a depth of so many centimeters.

It is not our purpose to belittle the importance of the recent progress in *x*-ray physics, but rather to insist that the clinical side of the work be given its proper consideration. At least two problems should be considered before the matter of depth dose is touched upon. These are: First, the sensitiveness of the normal structures to be rayed, and second, the nature and distribution of the malignant cells to be attacked.

Accurate data relative to the vulnerability of the internal structures is quite meager. We know that the mucous membranes of the gastrointestinal tract, the bladder and the trachea are relatively quite sensitive. Injuries observed in the intestines of experimental animals are described by Martin and Rogers.[1] Wintz[2] states that ulcers in the mucosa were observed in his pelvic cases. Evidence has also been brought forward suggesting that the pulmonary tissues may be injured. Intrathoracic changes are fully discussed by Groover, Christie and Merritt.[3] Mühlmann[4] has described untoward effects in fatty tissue. The salivary glands and the mucous membrane of the mouth are

NOTE. Many of the data used in compiling this article were taken from Ewing's book entitled "Neoplastic Diseases."

very easily influenced. And yet more work must be done and many accurate observations recorded before we can set down definite figures indicating the tolerance of these normal tissues. It is true that figures representing the tolerance of various tissues have been published, but the very fact that different authors disagree on these tolerance doses argues against their accuracy.

Our knowledge of the sensitiveness of the many forms of malignant tissue is also rather chaotic. We know that malignant tumors arising in the testicle, larynx, uterine cervix and breast are much more sensitive than those arising in the prostate, rectum and stomach; but there is little written regarding the exact order of sensitiveness. Wood,[5] in an effort to illustrate the present uncertainty regarding tumor sensitiveness, sets down the widely different doses proposed by Bumm and Seitz and Wintz for the cure of the same tumor. Here again, accurate records augmented by good pathological reports where they are obtainable, will slowly build up a scientific system of therapy. It may be true that various histological types of cancer arising in the same location possess varying degrees of susceptibility to irradiation, according to the cell type. Many theories of this order have been backed by little or no recorded clinical evidence, and must therefore, stand as theories only.

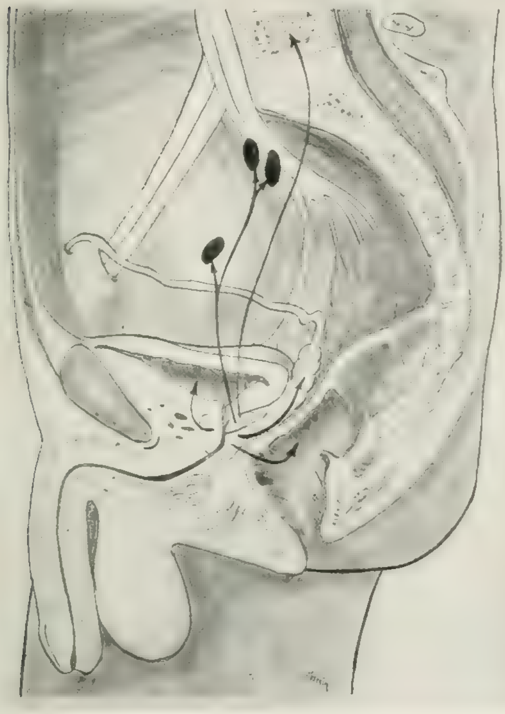


Fig. 1. Paths of metastasis within the pelvis secondary to carcinoma of the prostate.

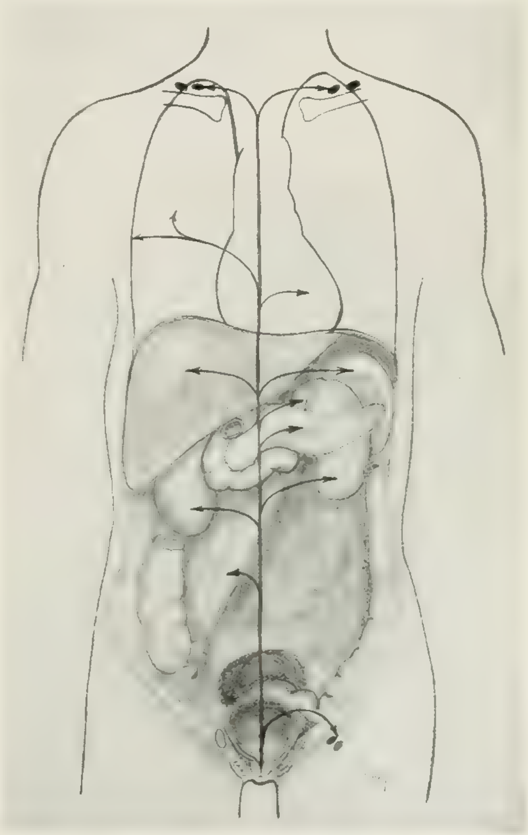


Fig. 2. Possible sites of wide-spread metastases in carcinoma of the prostate.

Although this biological data must be obtained in the future, there is much information now available relative to the distribution of cancer arising in the various well-known sites. Records written at the operating and autopsy tables indicate the relative malignancy of tumors and their most likely paths of extension. We have prepared a few charts illustrating the usual behavior of some of the more common neoplasms.

Figures 1 and 2 illustrate the mode of extension observed in carcinoma of the prostate. It is well to note that the prostate is bounded behind by the rectum and above by the bladder, while the urethra runs through it. The dose delivered is, therefore, definitely limited by the mucous membranes of these structures, regardless of the efficiency of our apparatus. The available evidence indicates that carcinoma of the prostate is a very resistant tumor. Bumpus,[6] of the Mayo Clinic, reports only 3 patients alive three years, out of 217 receiving radium therapy. Deming,[7] who has had much experience with radium therapy in prostatic malignancy at the Johns Hopkins Hospital, insists on very heavy doses, and states: "Thus far we have no actual proof that radium has produced an actual cure for cancer of the prostate and seminal vesicles." However, he claims that 75 per cent of his patients receive symptomatic relief and 50 per cent of the cases suffering from pain in the back are made comfortable. Such benefit from irradiation makes the method well worth while, even though it may not produce an actual cure. Symptoms relieved are frequency, nycturia, hematuria, hesitancy, dribbling, small stream, complete retention, residual urine, pain in the back and extremities, and loss of weight.

In examining patients, it is well to remember that a malignant area may be concealed within a simple hypertrophy or may appear on top of a hypertrophy and give rise to a hard nodular gland. On the other hand, the malignant area may be so small that it gives practically no symptoms until the patient is riddled with metastases. The earlier paths of spread are shown in Figure 1. Extension upwards along the seminal vesicles is common and can usually be palpated by a finger in the rectum as a hard nodular mass. However, involvement of the bladder and rectum may occur. One of our cases showed actual obstruction from nodular masses surrounding, but not invading, the rectum. With the exception of the inguinal nodes none of the pelvic glands invaded through lymphatic distribution can be discovered by physical examination. Most radiologists are familiar with the bone metastases so frequently found accompanying a prostatic neoplasm. Since these lesions are common in the lumbar spine, hips and pelvis, films of these regions should be taken as a routine part of the examination. Figure 2 represents the widely separated sites that may become involved when extension gets well under way. In such cases the secondary lesions often bring the patient to a hospital without his ever realizing that the trouble started in the prostate. About two years ago an old man was brought to Baylor Hospital because of weakness, loss of weight, anemia, and vague digestive disturbances. The supraclavicular nodes were involved on both sides and a plate of the chest showed the mediastinal nodes enlarged. Irradiation was started with the belief that the patient had Hodgkin's disease. He grew worse continually and after several months, died. A tissue examination revealed a prostatic carcinoma. A careful examination in the beginning might have discovered the diagnosis at that time. An accurate diagnosis usually makes possible an intelligent prognosis and the institution of the most beneficial form of treatment.

Figure 3 represents the types of extension associated with carcinoma of the stomach. The surgeons are badly in need of help in the treatment of this malady. The better clinics report about 20 per cent of three-year cures where only selected cases are operated upon. A glance at the chart will explain this high mortality rate. The circle is drawn around the arrows representing early metastases. The liver and the nodes beneath it are invaded early. All radiologists are familiar with the fact that gastric malignancy usually gives definite symptoms only after it has become well advanced. Consequently, metastases are usually well under way before the patient seeks aid.

Gastric tumors are always in close proximity to many intestinal mucous surfaces, which limit the safe amount of irradiation that can be given. The scarcity of favorable reports in the literature leads us to the conclusion that gastric cancer must be very resistant to irradiation. Ernst[8] reports 3 cases which showed a gain in weight and a relief of pain for eight and nine months following copper-filtered *x*-ray therapy. Our own experience has not been so satisfactory. The distressing symptoms usually met with are cachexia, anemia, hemorrhage, pain and digestive disturbances. It is to be hoped that someone will publish a description of a large series of cases which have been followed up carefully after irradiation, in order that the degree of symptomatic relief obtainable may be ascertained. The marked treatment sickness which follows irradiation of the epigastrium makes the treatment of this region quite difficult. When metastases have reached the supraclavicular nodes, the brain, or the pelvic viscera, the problem of administering homogeneous irradiation becomes a most complex one. It would seem, therefore, that treatment of carcinoma of the stomach will not be likely to yield the most favorable results.

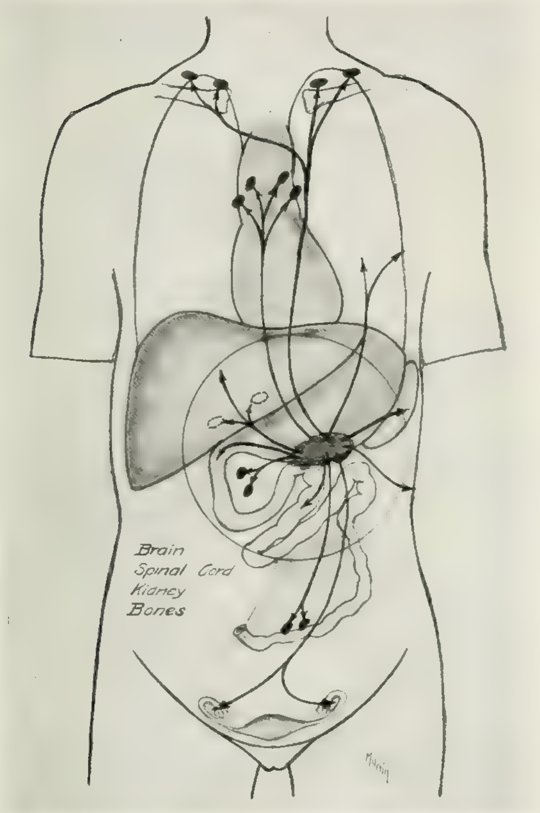


Fig. 3. Multiple paths of extension which have been observed with carcinoma of the stomach. The circle encloses earlier lesions which often appear before symptoms become prominent.

Figure 4 illustrates the extensions which usually accompany a carcinoma of the head of the pancreas. Malignancy of the tail and body does occur, but it is rare and its early detection is extremely difficult. The gall-bladder is shown markedly distended since the common duct is frequently occluded and a steadily progressive jaundice is one of the most suggestive symptoms. Epigastric pain is usually present and the patient shows a rapidly progressing cachexia. The tumor is almost completely surrounded by the duodenum and is covered over anteriorly by the stomach. Gastrointestinal mucosa, therefore, again limits the size of the safe dose. The literature offers little relative to the sensitiveness of cancer of the pancreas. Richards[9] reports 2 cases which showed increase in weight and relief of pain almost a year after copper-filtered irradiation. These results are encouraging. Since pancreatic metastases tend to remain within the abdomen and are usually situated within a relatively small area, the possibility of obtaining permanent results is much better than with gastric cancer where the extension is rapid and covers much territory.

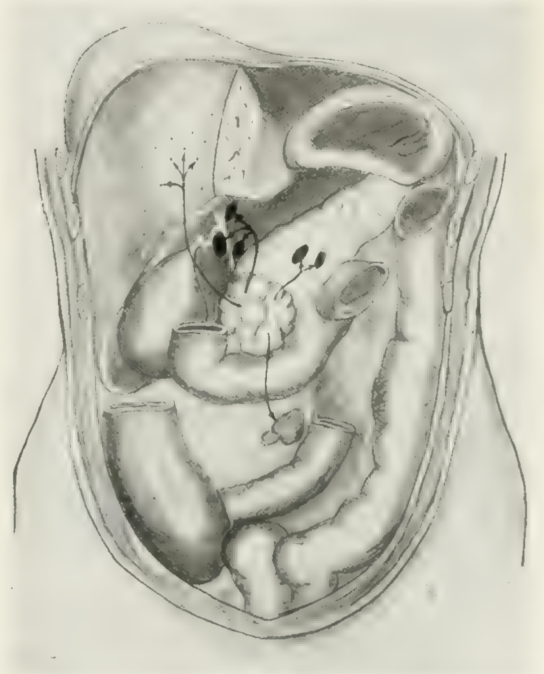


Fig. 4. Carcinoma of the pancreas rarely spreads outside the abdomen and the metastases occupy a relatively small area.

The problem centers about the relative sensitiveness of pancreatic cancer and the intestinal mucosa. Since a dose too small to produce a cure will often cause a temporary remission in the growth of a resistant tumor, treatment for palliation only is worth while, even where the normal structures limit the most effective dosage.

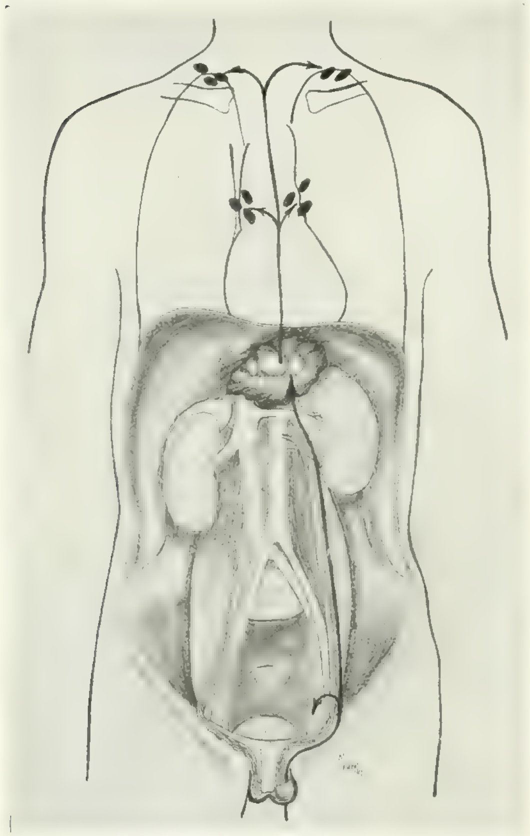


Fig. 5. Testicular tumors metastasize early and form rapidly growing abdominal tumors.

Cases of pancreatic malignancy are often operated on with a diagnosis of gall-stones. Such operations offer the radiologist an opportunity to discover the extent of metastasis; and he can plan his attack better after having been at the operating table. Surgeons usually do not trace out the various metastases, but a careful study of the conditions in the abdomen should be made if irradiation is to be resorted to. Where a cancer of the pancreas is discovered, a search should be made for enlarged glands beneath the liver and about the pancreas itself. The liver should be carefully examined, since the secondary nodules are sometimes quite small. The peritoneum and mesenteries should then be examined for nodules. It is especially important to determine the limit of downward extension if we are to treat all the diseased tissues.

The metastatic tendencies of malignant tumors of the testicle are illustrated in Figure 5. This drawing indicates only the paths of lymphatic distribution. Metastases following invasion of the iliac or spermatic veins may form new growths in the lungs, liver, brain, kidney and stomach. However, a large portion of the cases afflicted with this malady consult a physician because of a rapidly growing abdominal tumor, usually in the epigastrium. The primary growth in the testicle may have been completely overlooked. The lymphatics pass upward with the spermatic vessels and often the migrating cells pass rapidly up to the vicinity of the renal vessels before they begin to grow. They are occasionally halted further down and form tumors in the groin or iliac fossa. At a later stage mediastinal and

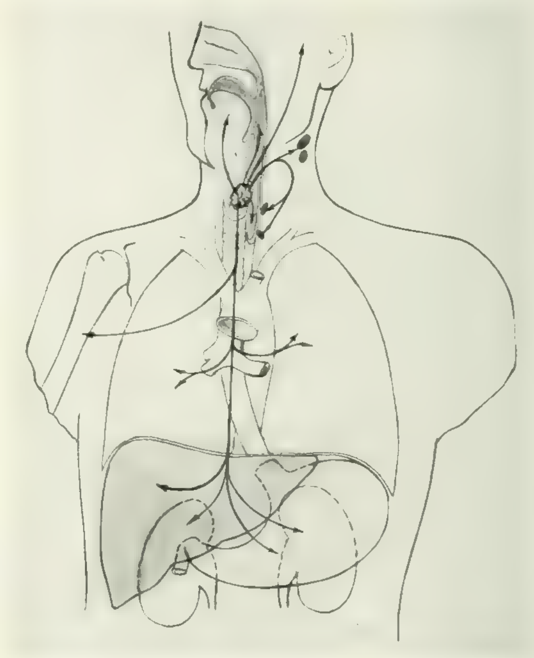


Fig. 6. Carcinoma of the larynx, when extrinsic in origin, may produce widely distributed secondary lesions, as shown by the arrows.

supraclavicular glands may be involved. The patients are usually young men who show a rapid loss of weight, fever, anemia and weakness as the disease advances. A great many of them have had one testicle removed shortly before the abdominal tumors appeared. These cases deserve a general examination, since it is of the greatest importance to attack the metastatic tumor. Fortunately, the cells of these tumors respond quite readily to irradiation. Bowing[10] reports prompt disappearance of the metastases in many of his cases treated with both radium and roentgen rays. Good results are usually obtained if the disease has not progressed too far. The tumors grow rapidly and metastases form very early. Surgical removal of the testicle often fails to cure the patient and should always be accompanied by irradiation applied to the epigastrium and along the whole length of the spermatic vessels. We have found no reliable data relative to three- or five-year cures in such conditions. Let us hope that accurate records of progress are being kept in some of the laboratories where such cases are under treatment.

The situation encountered in carcinoma of the larnyx is roughly represented in Figure 6. The points of origin of tumors in this region influence their clinical course. When the origin is intrinsic, that is, in or about the vocal cords, the tumor usually grows very slowly, is accompanied by considerable ulceration and secondary infection, and gradually invades the neighboring tissues, causing death by dysphagia, hemorrhage, suppuration and a terminal infection. When the origin is extrinsic, metastases form fairly early in the glands of the neck, both superficial and deep. Direct extension occurs in the tongue, pharynx and esophagus. The primary growth shows a marked tendency toward ulceration followed by suppuration. Late metastases may be found in the brain, chest and abdomen as indicated in the drawing. Cancer of the larynx is advantageously located for treatment, since it is near the surface and is accessible from several angles. The tracheal mucosa and the salivary glands are quite sensitive, but we at present have no accurate data concerning their relative sensitiveness as compared with that of laryngeal carcinoma. It has been shown however, that this type of growth often responds readily to irradiation therapy. The case reports published by Quick and Johnson,[11] Freer[12] and Pfahler[13] are most convincing.

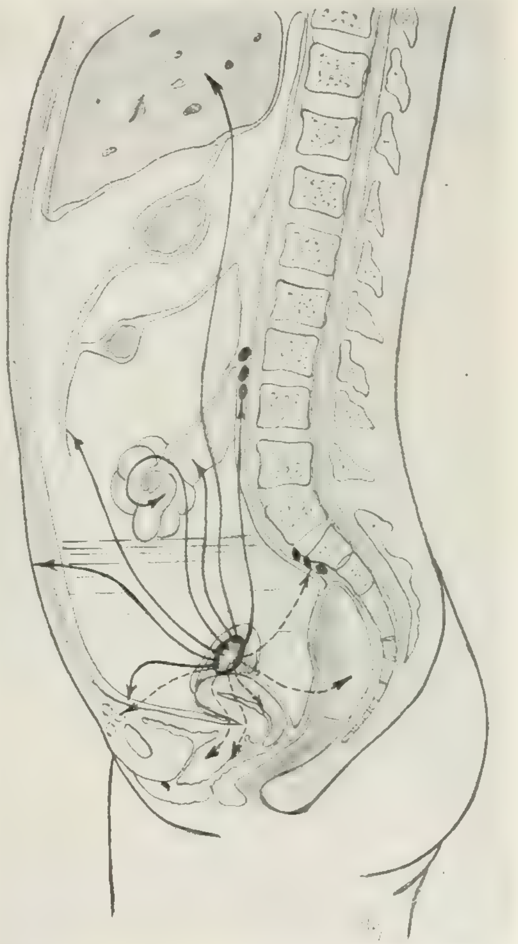


Fig. 7. The solid arrows represent the lines of spread observed with tumors of the ovary. The broken lines represent the paths of metastasis from intraligamentary tumors.

It is a puzzling fact that a certain number of the cases treated by these authors showed no improvement, while others cleared up rapidly. An investigation of the causes of these differences would be most interesting. One of our own cases showing almost complete occlusion of the pharynx and large cervical glands has remained free of visible pathology for eight months following copper-filtered irradiation. Good results can, therefore, be obtained with a number of these patients if they consult a radiologist before distant metastases have appeared.

The lines of extension commonly observed with malignant tumors of the ovary are portrayed in Figure 7. These tumors may be either cystic or solid, and the majority of them grow slowly and show a low grade of malignancy. The first symptoms are often caused by the metastases which commonly appear in the peritoneum, particularly the mesenteries and omentum, and may produce interference with peristalsis and actual obstruction. Ascites is likely to be present and adhesions may be plentiful. In advanced cases the liver and retroperitoneal glands are invaded and rarely subcutaneous nodules and bone metastases occur. Two cases have been referred to us which were operated on for intestinal obstruction. The cause of the obstruction was revealed by the pathologist who examined the resected specimens. The paths of spread for intraligamentary tumors are usually downward rather than upward, as indicated by the broken lines in the drawing. Roentgenograms of the abdomen made following the removal of fluid and the production of pneumoperitoneum have helped to make a diagnosis in well-advanced cases. Figure 8 shows a lateral view of the abdomen of a woman who had developed many large omental masses and adhesions and came to the hospital because of vague digestive disturbances associated with ascites. Needless to say, it is quite important to obtain a full report regarding the extent of metastases from the operating surgeons when a malignant ovary is removed. The outlook in cases showing a few peritoneal implantations in the pelvis is far superior to that in cases showing general abdominal extension.

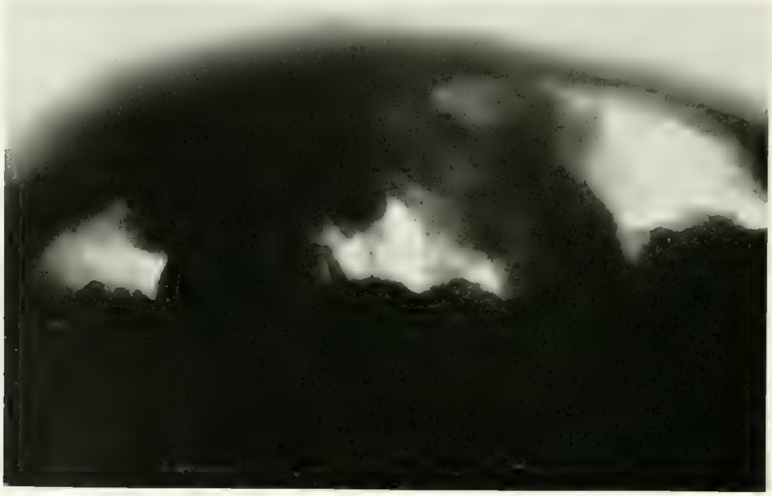


FIG. 8.—Lateral view of the abdomen following the removal of 4 qts. of fluid and the introduction of carbon dioxide gas in an advanced case of carcinoma of the ovary with multiple abdominal masses and adhesions.

The determination of the sensitiveness of ovarian tumors to irradiation is difficult. Most of the cases are treated after the primary growth has been removed surgically, and it is a well-known fact that peritoneal implantations often show spontaneous retrogression where no treatment of any kind is given following operation. It is not fair, therefore, to give all the credit for clinical improvement to irradiation. Schaefer[14] reports some excellent results in cases irradiated following radical surgery, although he had a number of failures. Belot[15] claims to have caused a disappearance of ascites and general improvement in a case with peritoneal metastases treated following operation. This evidence justifies the treatment of such patients, although the dosage must be regulated so as to safeguard the intestinal tract.

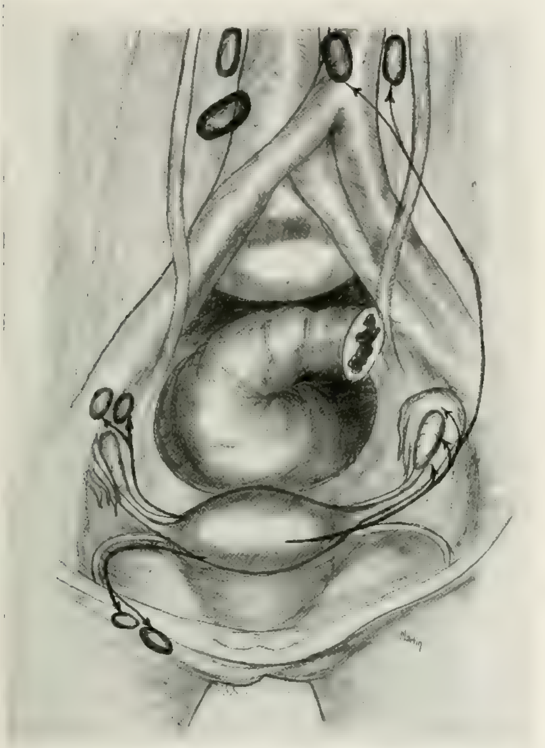


Fig. 9. Carcinoma of the uterus extends beyond the uterine walls at a late stage in the disease along the paths indicated by the arrows.

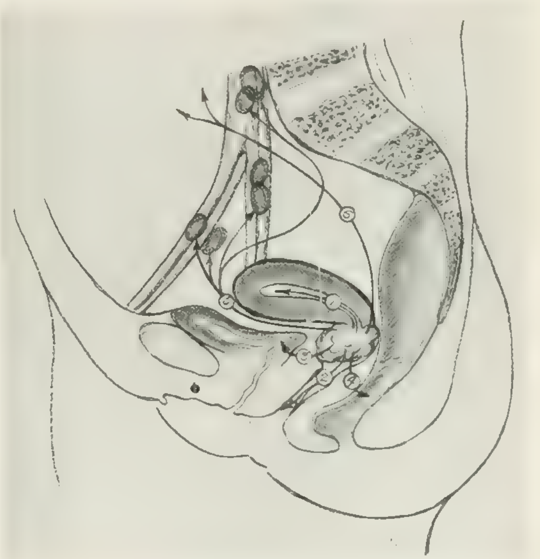


Fig. 10. Metastases from carcinoma of the cervix are usually limited to the soft tissues of the pelvis. Arrow No. 6 represents extension into the abdomen, which is a rare occurrence.

Figure 9 represents the paths of extension ordinarily observed with carcinoma of the fundus of the uterus. This lesion usually appears at or after the menopause, and the first sign is a discharge which later becomes bloody. Pain is a very late symptom. The discharge is likely to appear while the tumor is localized within the thick walls of the uterus, and consequently surgical removal is the treatment of choice in the earlier cases. The network of lymphatics which surrounds the tubes and ovaries is often invaded; it is therefore wise to do a total hysterectomy, if operation is decided upon. The symptoms of carcinoma of the fundus are identical with those caused by a number of benign lesions which may occur in the uterus, and a diagnostic curettage is the most essential step in making a diagnosis. One of the *x*-ray tables in our laboratory is made with a drop leaf and detachable stirrups, and an electrical sterilizer is placed near by. A diagnostic curettage can be done without materially disturbing the equipment of the *x*-ray room. All pelvic cases are examined on this table before and after treatment. When the lumbar, iliac or inguinal nodes have become involved, irradiation must be resorted to. Unfortunately, only the inguinal nodes are palpable from the outside, but it seems rational to cover the region occupied by the iliac and lower lumbar nodes in administering treatment, since they may also be involved. Clark[16] reports 12 cases alive from three to six years following the use of radium. Although it is not so stated, it is intimated that these were early cases. We have at our disposal no records indicating the sensitiveness of the cells making up the metastatic deposits in the nodes. One of our own cases developed a recurrence in the abdominal wall following operation. A very large dose of copper filtered *x*-rays was administered to this nodule which was just below the skin. The dose was large enough to cause a bloody diarrhea. The nodule completely disappeared, but returned in six months and began to grow rapidly. The same dose was repeated with the same intestinal effect and the nodule again disappeared, only to reappear in about six months. Conclusions should not be drawn from one case, but we are inclined to believe that the cells of these tumors are quite resistant so far as complete extermination is concerned.

The mode of spread accompanying carcinoma of the cervix is indicated in Figures 10 and 11. Almost everyone is familiar with the triad of symptoms (discharge, hemorrhage and pain) which is so characteristic of this affliction. The diagnosis of the primary lesion is usually easy where facilities for doing a routine pelvic examination are available. One of the most important procedures is a rectal examination. This is not done in an effort to examine the rectum itself, so much as to determine the degree of extension of indurated tissue out along the broad ligaments. Such extension is almost invariably present except in very early cases and its presence or absence plays an important rôle in the prognosis as well as the treatment. Should this induration be discovered when the cervix looks normal, the upper cervical canal should be examined with great care for the type of cancer that begins above the field of vision. On two occasions such cases were referred to us with a diagnosis of fibroids of the uterus by clinicians who had been misled by the normal picture seen through the speculum. A cystoscopic examination will determine the condition of the posterior bladder wall, which often has an appearance suggesting a group of crowded vesicles when actual invasion has occurred. Pain has, in our experience, many times been secondary to stricture of the ureter (Fig. 11) and in such cases a genitourinary consultant is asked to catheterize the ureter on the affected side, and a pyelogram is made. One is struck at once in studying advanced and recurrent cases with the frequency with which the chief complaint is pain in one hip and one side of the pelvis referred down to the groin and inner side of the thigh and up to the costovertebral angle. A high fever coming on top of such symptoms usually indicates the presence of a pyonephrosis. Figure 12 shows a dilated ureter and kidney pelvis which were produced by such a malignant stricture. Irradiation in this case gave complete relief of pain for a period of a year. However, such treatment has in our hands often failed to relieve these

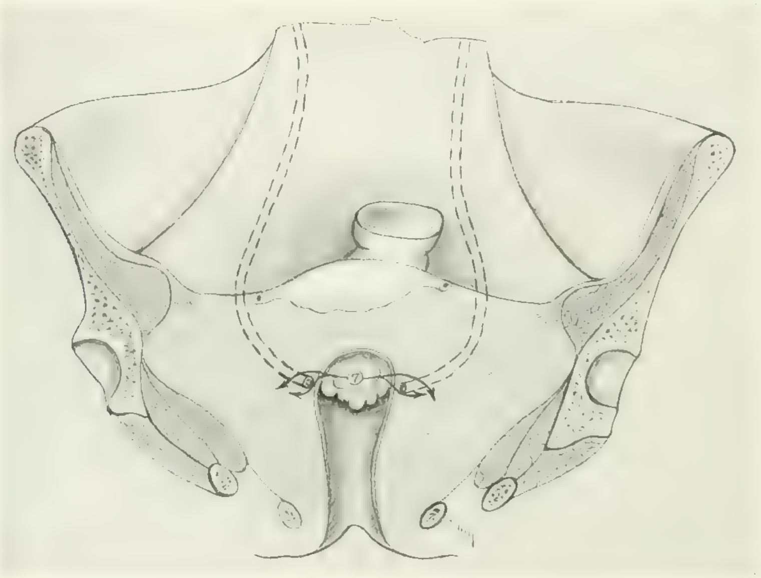


Fig. 11. Lateral extensions into the parametrium with occlusion of the ureters usually produce the fatal outcome in carcinoma of the cervix.

strictures. When both ureters are stenosed death is imminent. Ewing[17] states: "The natural termination of most cases of uterine cancer is through uremia from occlusion of the ureters." Fever is as likely to be due to a cystitis or pyelitis as an infection in the growth itself. Such an infection should be treated medically before irradiation is begun. Fistulae opening either into the rectum or the bladder may often be closed or partially closed by applying radium to the edge of the opening in quantities sufficient to cause marked contraction. The severe skin irritation about the vulva accompanying a fecal fistula has healed when kept continuously covered with a coating of zinc oxide ointment. Arrow 6 in Figure 10 represents extension up into the abdomen, but this type of extension is rarely encountered. It is for this reason that carcinoma of the cervix and its compactly arranged metastases are so effectively rayed. The deep pelvic glands are invaded late in the disease, but their enlargement cannot be detected from the outside of the body. When large doses are applied it should be remembered that the cervix is bounded in front by the bladder and behind by the rectum.

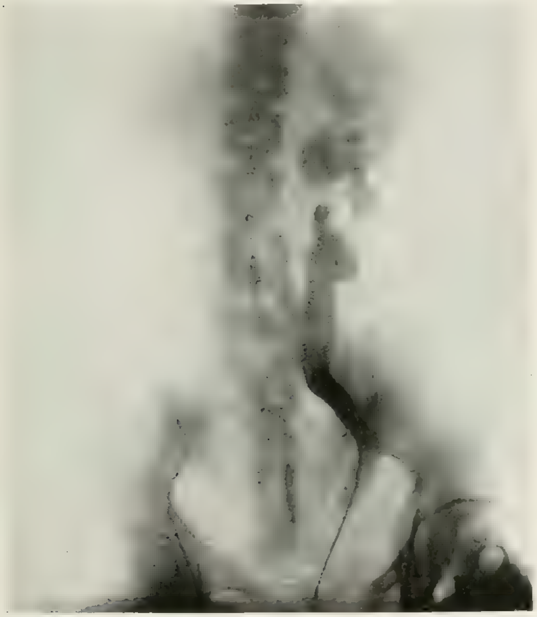


Fig. 12. Pyelogram illustrating a hydronephrosis caused by a stricture of the ureter secondary to carcinoma of the cervix. The symptoms were typical of stricture of the ureter.

The proof in the literature of the sensitiveness of carcinoma of the cervix is too extensive to be doubted and no attempt will be made to set down the many references which describe excellent results. It is an established fact that many early cases have been cured and many advanced ones relieved of symptoms. It is somewhat discouraging to note that Seitz[18] was unable to increase his percentage of five-year cures when deep x-ray therapy was added to the radium therapy already in use. Involvement of the bladder, rectum, vagina or ureters makes the prognosis poor, and the presence of such involvement should be known before treatment is begun.

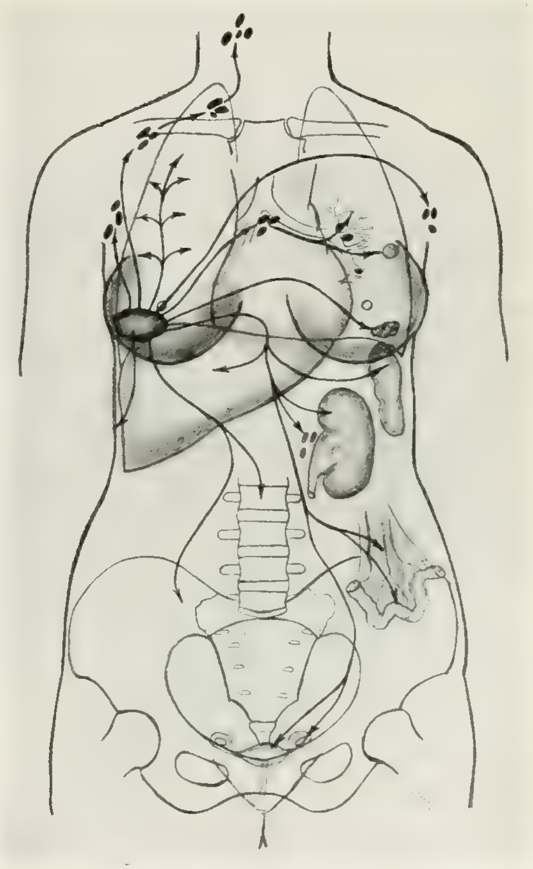


Fig. 13. The complicated metastatic possibilities in carcinoma of the breast.

The chart shown in Figure 13 represents the very complex situation encountered in cancer of the breast. It would be well for the surgeon to have this chart in mind when he is contemplating the removal of a breast for carcinoma, since many of these metastases occur early and are not touched by the most radical operation. This statement is well borne out by a table of statistics published by Sistrunk and McCarty,[19] of the Mayo Clinic. Two hundred eighteen cases operated upon for cancer of the breast were followed for five to eight years. Only 63.9 per cent of those showing no glandular involvement and 18.9 per cent of those showing glandular involvement were alive at the end of that period. In other words, 36.1 per cent of the cases having no glands in the axilla or neck died of metastases, and those cases that did have glands palpable had only one chance in five of being cured by a radical amputation. Obviously, the surgeon needs help. A careful physical examination should precede any form of treatment. Both axillae, both sides of the neck, both breasts and the subcutaneous tissues in general should be gone over with the fingers. The liver edge should be palpated and the abdomen examined for masses. Films of the chest, spine and pelvis should then be made, regardless of the symptoms. Films of the chest are of the greatest importance and should be repeated at regular intervals following treatment, since lung lesions often come on insidiously and cannot be detected with the stethoscope until they reach a considerable size. The various types of pulmonary lesions are well described by Carman.[20] Several cases have been referred to us following operation with definite lung involvement. These patients might have been saved a major operation if a radiologist had been called in consultation when the preliminary examinations were made. During the past three years we have treated our postoperative cases by covering the lymphatic channels over the chest as thoroughly as possible. Very few of these cases have developed pulmonary metastases. The majority of those that did not do well died with extreme pain in the lower back and hips, often in the absence of demonstrable bone lesions. We have assumed that the pain was due to the presence of enlarged retroperitoneal glands. Be that as it may, it seems probable that abdominal metastases were present at the time that treatment was started. The problem of applying homogeneous irradiation to such a widespread distribution of diseased tissue is not an easy one. We have been considering the advisability of beginning treatment over the lower spine and working upward, since the terminal lesions are so often in the lower portion of the body. There is no method available for the detection of most of the subdiaphragmatic secondary lesions and it is probably best to assume that they are always present.

Proof of the sensitiveness of the cells of breast cancer to irradiation is abundant and need not be established here. Numerous reports of the retrogression of palpable glands are also available. That deep-seated lesions may also be favorably influenced is illustrated by the roentgenograms of the chest shown in Figures 14 and 15. On Mar. 2, 1921, the patient underwent a radical removal of the left breast, and *x*-ray treatment was advised. The tumor was found to be an adenocarcinoma, but no histological evidence of malignancy could be made out in the axillary glands. The chest was clear at the time of the operation. Soon afterward a hard subcutaneous mass was found in the epigastrium and was rayed vigorously. The patient did well until Mar. 8, 1922, when she returned because of pain in the posterior portion of the right chest. The roentgenogram shown in Figure 14 was made at that time. The circular plaque seen at the right base is characteristic of malignancy and appeared to be attached to the diaphragm. The anterior posterior diameter of the chest measured 7 in. We administered 720 ma. min. to an area 20 cm. square laid out on the back of the right chest so that it was centered over the lesion shown in the film. The dose was given with 6 ma. flowing at a sphere-gap reading of 140 kv., a target-skin distance of 12 in., and a filter of ½ mm. Cu. and 1 mm. Al. We gave 360 ma. min. over the anterior chest wall using an area 15 cm. square. On Oct. 7, 1922, she returned, showing no loss of weight or strength. A film of the chest showed a retrogression of the plaque shown in Figure 14. She still complained of pain. We gave 360 ma. min. over the back over a 20 cm. square, but the patient refused further treatment because of a severe treatment sickness. On Mar. 17, 1923, she felt better and had still lost no weight. Figure 15 shows the chest as it appeared at that time. The nodule had almost completely disappeared. A year and four months have elapsed since the first treatment was given and the patient states in a recent letter that she feels well and is now free of pain. This case illustrates the importance of being constantly on the alert for new metastases. A repeated careful physical examination is by no means the least important procedure coupled with deep therapy.

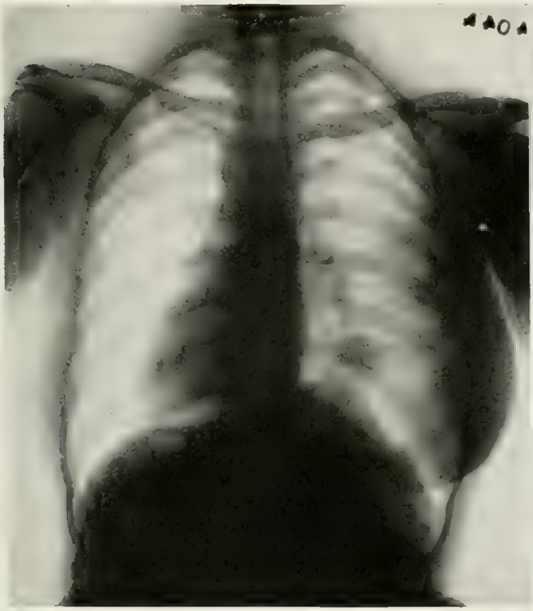


Fig. 14. An early metastatic nodule within the base of the right lung secondary to carcinoma of the left breast.

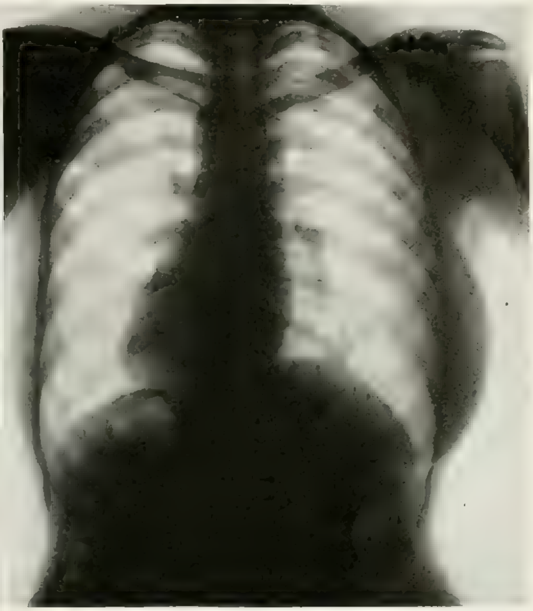


Fig. 15. A film of the chest shown in Figure 14 one year later. This result was obtained with intensive irradiation.

This brief paper illustrates a few of the problems in radiotherapy outside the field of physics. Needless to say there are numerous types of malignant tumors that we have not touched upon. An article dealing with all the known varieties would approach a book in size.

SUMMARY

The deep therapist should know something of the sensitiveness of the normal structures, the sensitiveness of neoplastic cells and the usual clinical progress of the various types of neoplasms, as well as the pure physics of depth-dose determination. Carefully written records containing repeated physical examinations will eventually establish the true value of our recent progress in *x*-ray physics as applied to the patient. The radiologist who can make an accurate diagnosis and give a reliable prognosis will soon acquire a place of dignity among his fellow-practitioners of medicine.

BIBLIOGRAPHY

1. Martin, C. L., and Rogers, F. T. Intestinal reaction to erythema dose. Am. J. Roentgenol., Jan., 1923, x, 11.
2. Wintz, Herman. Injuries from roentgen rays in deep therapy. Am. J. Roentgenol., Feb., 1923, x, 140.
3. Groover, T. A., Christie, A. C., and Merritt, E. A. Intrathoracic changes following roentgen treatment of breast carcinoma. Am. J. Roentgenol., June, 1923, x, 471.

4. Mühlmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1923, xxx, No. 3, p. 85.
5. Wood, Francis Carter. *Med. Rec.*, Mar. 11, 1922.
6. Bumpus. J. *Am. M. Assn.*, May 6, 1922.
7. Deming, C. L. *Surg., Gynec. & Obst.*, Jan., 1922.
8. Ernst. *South. M. J.*, June, 1922.
9. Richards, G. E. Possibilities of roentgen-ray treatment in cancer of the pancreas. Am. J. Roentgenol., Mar., 1922, ix, 150.
10. Bowing, H. H. *J. Radiol.*, Dec., 1922.
11. Quick, Douglas, and Johnson, F. M. Statistics and technique in the treatment of malignant neoplasms of the larynx. Am. J. Roentgenol., Sept., 1922, ix, 599.
12. Freer, Otto T. *J. Am. M. Assn.*, Nov. 4, 1922.
13. Pfahler, Geo. E. *J. Radiol.*, Dec., 1922.
14. Schaefer, P. *Arch. f. Gynäk.*, Dec. 30, 1922.
15. Belot. *Bull. et. mém. Soc. de radiol. méd. de Par.*, March, 1923.
16. Clark, J. G., and Keene, F. E. *J. Am. M. Assn.*, Aug. 20, 1921.
17. Ewing, J. Neoplastic Diseases. Philadelphia, 1922.
18. Seitz, L. *Arch. f. Gynäk.*, Dec. 30, 1922, cxvii, 258.
19. Sistrunk, W. E., and McCarty, W. C. *Ann. Surg.*, Jan., 1922.
20. Carman, R. D. *J. Radiol.*, Oct., 1921.

BIOLOGICAL REACTION OF X-RAYS: THE INFLUENCE OF X-RAY TREATMENT ON THE COMPLEMENT CONTENT OF THE BLOOD OF CANCER PATIENTS

BY CARL F. CORI, M.D.

With the Assistance of Miss H. DeNiord

From the State Institute for the Study of Malignant Disease

BUFFALO, NEW YORK

AMONG those constituents of the blood which vary in normal individuals within only very narrow limits is the complement. Mandelbaum[1] in 1916 stated that the complement content of the blood, if examined immediately, is constant not only for normal individuals, but also in a variety of diseases. This data for normal individuals was substantiated by Cori and Radnitz[2] in 1920, but could not always be confirmed in the case of diseased individuals.

No variation in the complement content of the blood of normal persons was observed even when examined during successive days or weeks. In disease, however, variations of the complement contents from its normal value may occur. Thus during the febrile period of various infections the complement is very often increased, returning again to normal at the end of the fever period.

This paper shows that patients under *x*-ray therapy may exhibit variations of the complement. These variations rapidly adjust themselves to normal after the *x*-ray treatment. Our data show that there are mechanisms in the body which attempt always to keep the complement at the same level. This fact is particularly brought out by Schütze and Scheller[1] who have proved that the complement of rabbits is restored in two to four hours after it has been completely used up by the injection of washed sheep corpuscles.

In a previous investigation[2] it was found that the complement titre of patients subjected to *x*-ray treatment is changed from its normal value. These experiments were repeated on a larger scale to see if there was any relationship between the amount of radiation received by the body and the variation of the complement.

EXPERIMENTS

The titration of the complement was as follows: 3–4 c.c. of blood was drawn from the cubital vein and centrifuged as soon as the blood was clotted. The clear serum was quickly worked up so that forty minutes after the blood was taken the system could be placed in the incubator. For the dilution of the serum the following technique was used: 0.5 and 0.4 c.c. of the serum was diluted to 1 c.c. with normal saline, 0.5 c.c. of these mixtures were transferred to other tubes containing 0.5 c.c. salt solution and the process continued as often as desired. In this manner different dilutions of serum were obtained, each subsequent dilution being exactly half of the preceding one. Each tube was made up to 1 c.c. by the addition of 0.5 c.c. normal saline. One c.c. of sensitized corpuscles was then added and each tube thoroughly mixed and incubated for one hour at 37° when the final reading was taken. The first tube that showed complete hemolysis and no trace of turbidity on shaking was chosen as the dilution indicating the titre of the serum. The dilution of serum in the tables is expressed as c.c. of serum present in each tube. The following dilutions were employed: 0.2, 0.125, 0.1, 0.075,[1] 0.06, 0.05, 0.03, 0.025, 0.015.

---

[1] Mandelbaum. *Münch. med. Wchnschr.*, 1916, p. 1039.

[2] Cori and Radnitz. *Ztschr. f. Immunitätsforch.*, 1920, xxix, 445.

[1] Schütze and Scheller. *Ztschr. f. Hyg., u. Infections-krankh.*, 1901, xxxvi, 459.

The sheep corpuscles were sensitized as follows: equal parts of 2.5 per cent corpuscles and amboceptor were mixed together as quickly and thoroughly as possible. The amboceptor obtained from the Lederle Antitoxin Company was used in a concentration three-fold the strength necessary for complete hemolysis.

In connection with this investigation it was of greater importance to calculate the entire *x*-ray dose received by the body than to record the skin dose or the tumor dose, since changes in the complement are systemic effects. For the calculation of this body dose a certain unit "Ax" was used, the definition of which will be given by Dr. Stenström in another paper.

TABLE I

THE COMPLEMENT CONTENT OF THE BLOOD OF NORMAL PERSONS

Cases	Date	Complement
1	10/18/22	.05
	4/17/23	.05
2	10/18/22	.06
	4/17/22	.05
3	10/18/22	.05
	10/18/22	.03
	4/17/22	.05
4	10/18/22	.05
5	10/18/22	.05
6	10/18/22	.05
7	10/18/22	.05

This table shows that there is no appreciable variation in the complement content of normal individuals. The normal value for complement is 0.06–0.05.

Table II

COMPLEMENT CONTENT OF THE BLOOD OF TUMOR PATIENT

Cases	Complement
2	.1
3	.075
12	.06
37	.05
13	.03
8	.025
2	.015

The data indicates that 64 per cent of the patients examined were within the normal complement limits, while 30 per cent were above and 6 per cent below the average value. All these cases with the exception of 2 had a negative Wassermann. The influence of radiation on the complement contents of the blood of tumor patients is shown in Tables III, IV and V.

These tables show the following facts:

1. Patients under *x*-ray treatment may undergo changes in their complement values. These variations of complement content do not seem to bear any close relationship to the amount of radiation received by the body, since patients with the same type of lesion and same quantity of radiation may show an increase or decrease of complement. This behavior reveals great individual differences of patients in their response to radiation. This is in contrast to the more uniform sensitiveness of the skin toward *x*-rays as measured by the constancy of the erythema dose.

2. Table IV, in which very small radiation was employed, tends to show that no change in complement occurs below 150 Ax. Above this quantity of radiation changes of complement are likely to take place. However, no general rule can be made, since it will be seen (Table III) that even with very high radiation (3,590 Ax) no fluctuation of complement will occur.

3. It is interesting to note that a large percentage of those patients in whom a pronounced drop of complement took place after radiation had already died when this work was completed. This observation may be of prognostic value for determining whether it is safe to continue with *x*-ray treatment. Thus it may be used as a measure of the amount

---

[1] The tube containing 0.075 c.c. of serum was prepared from the dilution 0.25, the latter being omitted.

Table III

EFFECT OF HEAVY RADIATION ON THE COMPLEMENT CONTENT OF THE BLOOD OF CARCINOMA PATIENTS

Carcinoma of the Cervix

	File Number	Lesion	Complement Before		Body Dose		Complement After		Remarks
			Date	Value	Date	Ax	Date	Value	
1	7415	Group 4	2/27/22	.06	2/28/22	1040	3/1/22	.2	Died
2	7473	....	11/23/22	.05	11/27/22	1110	11/27/22	.05	
3	7744	Group 3	1/11/23	.05	1/11/23	1490	1/12/23	.05	
4	6969	Group 4	3/28/22	.03	3/30/22	1630	3/31/22	.05	
5	7748	Group 2	10/24/22	.05	10/24/22	1820	10/24/22	.05	
6	7872	Group 3	2/19/23	.025	2/19–20/23	1950	2/21/23	.03	
7	7754	Group 4	10/10/22	.015	11/14–15/22	2250	11/16/22	.075	
8	7646	Group 4	3/ 7/23	.05	3/ 8/23	2510	3/ 9/23	.06	
9	7871	Group 4	2/22/23	.05	2/22–23/23	2730	2/23/23	.05	No history
10	7653	Group 3	11/28/22	.05	11/28/22	2970	11/29/22	.05	No history
11	7869	Group 3	2/19/23	.05	2/20–21/23	3070	2/21/23	.05	Died April, 1923
12	7665	Group 3	4/ 4/23	.05	4/ 6/23	3590	4/ 7/23	.05	
13	7830	Group 4	2/27/23	.05	2/27/23	3540	2/28/23	.05	
14	7094	Group 3	1/ 9/23	.05	1/ 9/23	3670	1/11/23	.025	
							1/16/23	.05	
15	6156	Group 4	4/ 7/22	.05	4/ 6/22	3710	4/ 6/22	.125	Died July, 1922
							4/11/22	.05	
16	7887	Group 4	1/23/23	.05	1/23/23	3960	1/23/23	.03	
17	7778	Group 3	11/22/22	.05	11/22/22	4080	11/23/22	.025	
18	7875	Group 2	2/21/23	.05	2/21/23	4590	2/22/23	.025	
Carcinoma of the Rectum									
1	7737	Group 3	10/27/22	.025	11/24/22	1780	11/25/22	.05	
2	7374	Group 4	4/19/22	.05	4/20/22	1780	4/21/22	.2	Died Oct., 1922
							4/27/22	.05	
3	7398	....	3/21/22	.03	3/21/22	1680	3/22/22	.2	No history
4	7199	....	4/25/22	.06	4/26/22	1530	4/26/23	.1	Died Feb., 1923
							5/ 1/23	.05	
Hypernephroma Right Kidney									
1	7393	....	3/28/22	.05	3/30/22	1460	3/31/22	.125	
2	7863	....	2/ 8/22	.03	2/ 8/22	1300	2/ 8/22	.03	
Carcinoma of the Breast									
1	7350	Group 3	3/19/22	.05	3/19–20/23	960	3/20/23	.03	
2	7703	Group 3	3/ 8/23	.06	3/ 9/23	1350	3/ 9/23	.06	
3	7292	Group 4	12/14/22	.1	12/14/22	1370	12/16/22	.03	
							12/20/22	.1	Died June, 1922
4	7041	Group 4	3/19/22	.06	3/20/22	1760	3/20/22	.025	
							4/12/22	.05	
5	7347	....	3/ 2/23	.03	3/ 2/23	2280	3/ 2/23	.025	
6	7315	....	3/24/22	.05	3/29/22	3080	3/ 3/22	.05	
7	6615	Group 4	3/27/22	.05	3/27/22	3140	3/27/22	.05	
8	6681	Group 4	3/16/22	.075	3/ 6/22	3230	3/ 7/22	.1	
9	6403	....	1/23/23	.06	1/24/23	3710	1/24/23	.03	
							2/ 1/23	.06	
Carcinoma of the Esophagus									
1	7740	....	11/28/23	.05	11/28/23	1320	11/29/23	.03	No history
Carcinoma of the Bladder									
1	7889	....	3/ 6/23	.03	3/ 7/23	1900	3/ 7/23	.05	
Sarcoma of the Bone									
1	7677	Group 3	11/25/22	.06	11/27/22	1360	11/27/22	.03	Died May, 1923
			11/31/23	.06	2/ 1/23	1480	2/ 1/23	.03	

TABLE IV

EFFECT OF LIGHT RADIATION ON THE COMPLEMENT CONTENT OF THE BLOOD OF CARCINOMA PATIENTS

	File Number	Lesion	Complement		Body Dose		Complement	
			Date	Value	Date	Ax	Date	Value
1	7431	Lip	5/12/22	.025	5/12/22	*	5/12/22	.03
2	6319	Cheek	5/18/22	.03	5/19/22	*	5/19/22	.03
3	7529	Lip	5/16/22	.025	5/16/22	*	5/16/22	.025
4	7490	Lip	5/24/23	.05	5/24/23	*	5/24/23	.05
5	7509	Lip	5/19/22	.05	5/19/22	*	5/19/22	.05
6	6750	Breast	6/ 5/22	.025	6/ 7/22	*	6/ 7/22	.025
7	7718	Cervix	3/22/22	.05	4/ 8/22	130	4/ 8/22	.03
8	6930	Lip	5/13/22	.025	5/13/22	150	5/13/22	.025
9	6737	Lip	5/28/22	.05	5/25/22	170	5/25/22	.05
10	7467	Arm	3/30/22	.06	3/30/22	210	3/31/22	.03
11	5912	Larynx	1/11/22	.05	1/11/22	400	1/12/22	.05
12	6726	Cheek	5/10/23	.025	5/13/23	430	5/13/23	.015
13	7683	Lymph-nodes	11/23/22	.06	11/23/22	460	11/23/22	.075
14	7470	Jaw	4/ 3/22	.075	4/ 3/22	480	4/ 3/22	.03
..	....	....	....	....	....	...	4/ 4/22	.075
..	....	....	....	....	....	...	4/ 5/22	.075
15	7411	Thorax	2/25/22	.1	2/27/22	570	2/28/22	.075
16	7683	Lymph-node	11/28/22	.05	11/28/22	720	11/28/22	.05
17	7260	Ear	3/13/22	.075	3/14/22	800	3/14/22	.075

*Four-minute treatment.

TABLE V

EFFECT OF DIVIDED x-RAY DOSES ON THE COMPLEMENT CONTENT OF THE BLOOD OF CARCINOMA PATIENTS

Number	Lesion	Complement		Body Dose		Complement		Remarks
		Date	Value	Date	Ax	Date	Value	
7879	Breast	2/27/23	.05	3/ 6/23	790			
	Group 1	3/ 1/23	.05	3/ 7/23	790	3/ 7/23	.025	
		3/ 3/23	.05	3/ 8/23	790			
				3/ 9/23	790	3/ 9/23	.025	
						3/12/23	.03	
						4/ 9/23	.05	
7925	Breast	3/26/23	.05					
	Group 3	4/ 2/23	.05	4/ 2/23	1600			
				4/ 3/23	1600	4/ 3/23	.075	
				4/ 4/23	1600			
				4/ 5/23	1600			
				4/ 6/23	1600			
				4/ 7/23	1600	4/ 7/23	.075	
						4/ 9/23	.06	
						4/30/23	.05	
7918	Femur	3/19/23	.03					
		3/20/23	.03					
				3/21/23	480			
				3/22/23	480	3/22/23	.05	
				3/23/23	480	3/23/23	.06	
						3/24/23	.05	

of radiation tolerated by the individual. To establish finally the practical application of this observation it would be necessary to evaluate the complement of a large series and variety of cases.

In order to see if these variations of the complement were due to the direct action of the *x*-rays on the blood, the following test-tube experiments were performed. Defibrinated blood or serum of patients which showed an increase of their complaint on radiation was placed in narrow test-tubes of equal diameter and subjected in a thin layer to radiation. As soon as radiation was completed the tubes were placed on ice and the titre determined as quickly as possible. Control tubes were treated in a similar manner with the exception that they received no radiation. In these experiments an increase of complement was never observed. On the contrary a decrease took place after about eight to ten minutes' radiation with 2.5 mm. Al., 141 kv., 5 ma. and 30 cm. distance. These facts indicate that the increase of complement observed after the *x*-ray treatment of certain patients is due to factors other than the influence of radiation on the blood itself. Since in spite of the destruction of the complement of *x*-rays patients after radiation often show no change or even an increase, one must assume that new complement is being liberated into the blood stream. In those patients showing a diminution of the complement the regenerative process is, or has been, apparently delayed. That this is the case is shown in Table III by the fact that the complement eventually returns to its original value. The rate of regulation of the complement is best seen in Table V, where divided *x*-ray doses were employed.

Thus it will be seen that it takes several days for the complement to return to its original value, whether it has been increased or decreased by the *x*-ray treatment.

CONCLUSIONS

1. The complement content of the blood of normal individuals varies within very narrow limits (0.06–0.05).

2. *X*-ray treatment may cause an increase or decrease of the complement.

3. These changes in the complement are not closely related to the total amount of radiation received by the body, but seem to depend upon the individual difference of the patients treated.

4. The complement always returns gradually to its original value after the *x*-ray treatment has been discontinued.

5. A decrease of complement is always obtained when blood or serum is radiated *in vitro*. This fact indicates that the increase of complement observed after the *x*-ray treatment of certain patients is due to factors other than the influence of radiation on the blood itself.

6. A pronounced drop of complement after *x*-ray treatment seems to be of prognostic value, since the majority of those patients who showed this reaction had already died when this work was completed.

We wish to thank Dr. B. F. Schreiner for the privilege of examining the charts, and Miss Cora Geisler who assisted in some of the determinations.

TUMORS OF THE PITUITARY GLAND*

BY JOSEPH T. MCKINNEY, M.D.

ROANOKE, VIRGINIA

THE marked interest in tumors of the pituitary gland and its secretory disturbances within the past few years has been due not only to the intensive study of endocrinology and the internal secretions by the medical profession as a whole, but in a larger measure to the greater accuracy with which an early diagnosis of hypophysial lesions can be made. Since the results obtained by operative procedures for pituitary tumors have been so encouraging in the early cases, the operation is no longer dreaded as formerly, and the risk is no longer as great on account of the advance and development of improved surgical technique.

An increasing number of these cases is daily being sent to the roentgenologist for study of the appearance of the sella turcica and skull. The roentgenologist, if he be in the truest sense of the word a consultant, daily reminding himself above all else that he is a physician practicing roentgenology rather than a technician, should be familiar with some of the evidences of the symptomatology, clinical history and physical findings in disturbances of the pituitary gland.

In arriving at an early diagnosis of pituitary tumors, there should be the closest correlation of the findings of the ophthalmologist, neurologist, surgeon and roentgenologist. To wait until marked optic atrophy has occurred before making a diagnosis leaves no hope of restoring the patient's vision; for then an operation will give no relief. The importance of making an early diagnosis cannot be too strongly emphasized.

Most of these patients begin to notice failing vision and headaches, and it is these symptoms that send them to the physician. The lowered visual acuity is not relieved by glasses. The headaches are usually bitemporal and worse at night. All or a part of the following symptoms accompany the ocular changes: headache, accession of bodily weight, increase in the size of the hands and feet, spacing of the teeth in the inferior maxilla, sexual impotence, drowsiness and inability to concentrate on mental work.

Since in many cases there is an absence of constitutional disorders and negative findings of the central nervous system, the ocular changes and roentgen-ray appearance of the sella offer the best means of making an early diagnosis.

The symptoms then, in pituitary lesions may be classified as those due to: (1) Secretory derangements, hyper- or hypo-pituitarism, (2) those resulting from extension or involvement of the surrounding cerebral structures, (3) headache resulting from intracranial pressure, (4) those due to involvement of the optic chiasma and tract.

With the varying symptomatology of the secretory disturbances of the gland we shall not deal. In fact it is extremely doubtful if surgery should ever be advocated for anything other than failing vision, or relief of intracranial pressure with accompanying headaches.

The ocular findings depend upon the size and position of the tumor; but the characteristics most often noted are lowered visual acuity, a progressive narrowing of the visual field, showing either a bitemporal or homonymous hemianopsia, with at times absence of light perception in one eye and temporal defects in the other eye. Near vision as well as distant vision is usually affected. In all stages the loss of color perception is usually in advance of that for form and the first perimetric indication of the process is shown by a temporal form field and a corresponding quadrantal defect in the color peripheries.

Benedict of the Mayo Clinic reports a peculiar pallor of the nerve head without shrinkage, which is seen so often that it is almost diagnostic. This pallor is not due to atrophy of the optic nerve, unless the vision has been entirely destroyed. The nerve substance itself is pale, but otherwise not noticeably changed. This pallor may appear in about four months after the onset of visual disturbances. If of longer duration in showing up, there most probably is a slow-growing tumor. Early optic atrophy indicates rapid pressure changes and is usually due to malignant tumors or cysts. Benedict, in reviewing 32 cases, reports lowered visual acuity of one or both eyes in every case. The onset of visual disturbances most frequently is gradual. He mentions one case of pituitary tumor where visual disturbance began nineteen years before the operation, in one eye, and four years before, in the other eye.

---

* Paper submitted with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

Clifford Walker, in a review of 271 cases showing hypophysial involvement, found 183 showing tumor manifestations, and 148 field disturbances. Of the field disturbances, 47 cases showed bilateral hemianopsia, 22 cases homonymous hemianopsia, and the remainder were blind in one eye. In other words, the bitemporal defects occur only about twice as often as the homonymous.

Valuable as the ophthalmological examination is in making a diagnosis, it is also of great aid in determining the progress of the lesion, and whether or not optic atrophy has occurred; for if it has, and is of any length of time in standing, vision will not be improved by operation.

In the roentgen examination of the sella, plates of clear detail and definition are essential—lateral stereoscopic plates of the skull at a distance preferably of 36 in. according to Hickey's experiments, making the shift from above downward toward the feet, rather than from the glabella toward the occiput, and centering over a point obtained by drawing an imaginary line from the glabella to the external auditory meatus. At a point 1¼ in. anterior to the meatus on this line, a perpendicular line ¾ in. high is erected, and through the point established at the end of the perpendicular the principal ray is passed so that it will emerge at the corresponding point on the opposite side. The floor of the sella must be sharply defined, and the anterior and posterior clinoid processes superimposed upon their opposites.

While changes in the contour of the sella commonly exist in pituitary tumor, and when found are of great help in making a diagnosis, it is however well known that enlargement of the sella with even destruction of certain or all of its parts may result from other intracranial disorders, or from tumors situated in other portions of the brain. Heuer and Dandy, in a series of 100 cases of brain tumor, report that the roentgenograms of 21 of these patients, none of whom had hypophysial or super-sella tumors, showed any destruction of the sella turcica, or atrophy of its posterior clinoid processes. Also a pituitary tumor of some size may be present, showing rather characteristic ocular phenomena, without changing the roentgen appearance of the sella.

The roentgen findings, then, of pituitary tumors may be divided into four groups: (1) No enlargement of the sella, nor erosion of the base or clinoid processes, i.e., patients without roentgen findings, (2) enlargement of the sella without erosion or destruction of the sella, (3) enlargement of the sella with thinning of the base and floor, and erosion of the clinoid processes, (4) complete destruction of the sella. To these might also be added the roentgen evidence of changes in the skull, due to general increased intracranial pressure, as enlargement of the skull, separation of the cranial sutures and vascular changes in the skull due to tumor.

Unfortunately, however, the exceedingly wide variation in the size and character of the sella noted in normal individuals who show no evidence of pituitary disturbances, permits of no absolute definite rule as to when we are dealing with early changes and variations in the contour of the sella. Since it is so essential that an early diagnosis of pituitary tumor be made, the roentgenologist must be absolutely familiar with the wide variations met in normal individuals. With this knowledge and with good technique he will be able to visualize early changes. It is important that he should note to what extent, if any, the sphenoidal sinus has been encroached upon by a tumor of the hypophysis.

The pituitary tumors most often found are adenoma, frequently with cystic developments. To quote Frazier: "About 75 per cent of pituitary tumors are adenomata.

Comparatively few are malignant and practically never metastasize to the other organs. This means that if we can prevent a recurrence of local or general intracranial pressure the life of the patient may be prolonged."

A review of the available literature shows that about 10 per cent of the adenomata of the pituitary gland develop cysts which are quite frequently very rapid in their growth. Mere evacuation by puncture gives only temporary benefit, and these cysts soon fill up again unless the operator removes a portion of the cyst wall. This is more easily accomplished by the fronto-orbital route. The prognosis is most grave in cases of sarcoma, and most favorable in cases of cysts. Walker concludes that the cases showing homonymous defects, when operated on, are not quite as successful as the bitemporal hemianopsias.

The two methods of operation most often used are Cushing's transphenoidal or submucous septal approach, and Frazier's fronto-orbital method. The mortality of each method is about the same. Frazier concludes that the cranial method is safer, for by not having to depend upon artificial illumination, one can get a better view of the tumor growth. By the endonasal or transphenoidal route, meningitis must always be reckoned with, and as a matter of fact has caused the majority of deaths following the operation, due to infection from the sphenoidal sinus. Adson of the Mayo Clinic probably favors the intradural approach, after an osteoplastic flap has been turned from the right frontoparietal region, the dura being opened widely to permit the exposure of the frontal lobe. It is well to state that it is not possible to determine accurately the extent of the lesion before operation, either by roentgen ray examination, or the ocular findings.

Dandy and Heuer, in a review of a series of 70 cases of brain tumor, state that 10 per cent of these patients were blind on admission. They believe that surgical measures, as soon as choked disc is diagnosed, should be considered, and that by operating at this time, blindness would, to a large extent, be prevented. One of the most important features of the operative technique is the control of hemorrhage. The average mortality is about 30 per cent, though Cushing and Frazier report 8 to 10 per cent in their own practice.

In a recent article, "The Effects of Radium Emanations Upon Brain Tumors," Dr. Frazier has opened up a most interesting field of investigation. Because brain tumors are often inaccessible and very difficult to localize, and because as a rule they are slow in growing, Frazier began treating them with radium, in 1914, under Dr. Henry Pancoast's direction. He quotes in his paper 3 cases in particular in which there appears to be undoubted proof that the growth of the tumors has been arrested or probably destroyed. One of these cases, that of pituitary struma, was given *x*-ray and radium treatment, the radium being directly embedded in the pituitary body through the posterior nares. This case had a return of headache and visual disturbances nineteen months after a sella decompression was performed. But after the patient had been treated as indicated above, there was a relief of the visual disturbances and headaches, and a re-establishment of menstruation.

Blumberg has recently reported 1 case of hypophyseal tumor in which disturbances of vision and beginning atrophy of the optic nerve were present in one eye, and the other eye was totally blind. In this case the trouble was brought to a permanent standstill by several series of irradiations with mesothorium.

In a short article in the A.M.A., "The Normal Sella," Dr. C. D. Enfield has well brought to our attention the wide variations in the appearance, size and contour of the normal sella, and affirmed very positively that no roentgen-ray diagnosis of pituitary tumor or disturbance should be made unless there is marked erosion or positive evidence of bony changes in the sella.

The excellent work of Dandy and his followers on ventriculography, while of most practical value in diagnosing early internal hydrocephalus, may also be of great aid in diagnosing selected cases of suspected tumor of the hypophysis, or in locating and demonstrating the presence of the tumor in other portions of the brain, with its consequent pressure upon the pituitary gland and adjacent structures.

The recent work of Osborne, Sutherland, and Scholl, "Roentgenography of Urinary Tract during Excretion of Sodium Iodid," while primarily intended for examination of the urinary tract, offers a wide field for further investigation and possibilities along this or similar lines in the roentgen-ray diagnosis of tumors of the pituitary gland with the use of sodium iodid solution, or some other vehicle, which might aid in outlining the shadow of the tumor and other brain structures. Obviously, however, no conclusions as to the practical value of observations or work along this line can be drawn at this time.

The following recent case reports of pituitary tumors are fairly typical of the condition:

Case I. Male, aged twenty-six. Referred by Dr. M. L. Faville, a nose and throat specialist, October 15, 1920. Past history of no special significance, other than the fact that the patient has always been a little heavy for his size and has had scant beard. On September 15, 1920, he began to suffer with pain on the left side of the face. Two teeth were extracted, but this did not relieve the pain, which was dull and continuous, and much worse at night. About the middle of October, he began to notice some blurring of the left eye, which was followed in a week by a similar blurring in the right eye. There was a noticeable absence of bitemporal headaches, no change in libido sexualis, and no polyuria.

Subjective findings showed: (1) Early primary optic atrophy, (2) bitemporal hemianopsia, (3) deformity of the sella, (4) patient slightly obese.

Objective findings reported by the oculist were: "Fundus O. D. disc of normal size and shape. The temporal margin particularly is very pale, but there is a corresponding pallor of the nasal portion." X-ray examination on November 4, 1920, showed marked evidences of increased intracranial pressure, as shown by changes in the sella turcica. The anterior clinoid processes were definitely destroyed, the floor of the sella practically invisible, there being a definite round shadow about the size of a walnut in the region of the sella. The sphenoidal sinus was considerably decreased as a result of encroachment by the hypophysial growth. A roentgen diagnosis of pituitary tumor was made, and Dr. Faville concurring in this from his ocular findings, decided to send this patient to Dr. Harvey Cushing.

In his report to Dr. Faville, Dr. Cushing stated: "This is an extraordinary case in view of the huge sella and the complete absence of symptoms until very recently. It is quite possible that I should have surmised a big struma containing hemorrhagic cyst. Undoubtedly it was this cyst formation from hemorrhage which led to the recent onset of symptoms."

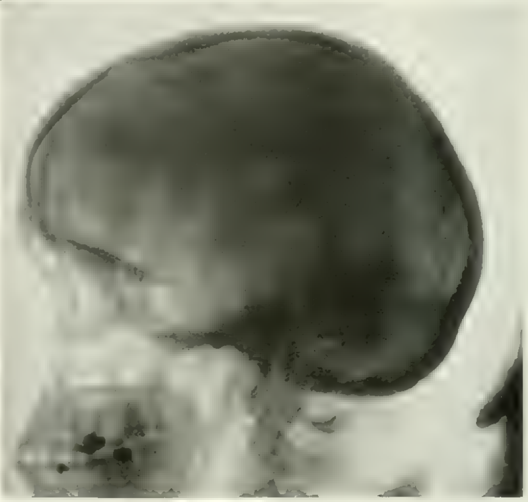


Fig. 1. Case I. Sella completely destroyed. Distinct large round shadow visible. Sphenoidal sinus encroached upon. Operative findings, hemorrhagic cystic adenoma of pituitary.

On November 13, 1920, Dr. Cushing operated, using the transphenoidal route finding the pituitary body about the size of a golf ball, with no bone whatsoever left in the floor of the sella. An incision made in the midline of the tumor showed soft yellowish gland protruding. Suddenly about 10 c.c. of dark, blackish blood gushed out, evidently a hemorrhagic cyst.

It is of interest to note further that eight months after Dr. Cushing's operation, this patient developed what was thought to be an acute intestinal obstruction. He was operated upon in Asheville, N. C., and found to have an acute pancreatitis. He fully recovered from this operation and at the present time (September, 1923) his vision is good and he is attending to his daily work. It is an interesting speculation to what extent, if any, the disturbance of his pancreas followed the operation upon his pituitary gland.

Case II. Male, aged fifty-two. Referred by Dr. H. B. Stone, a nose and throat specialist. Gives history of visual disturbances for the past four years, not relieved by glasses. Onset of visual symptoms gradual. Headaches, bitemporal in character, worse at night, though for the past several months have been better. Began putting on fat six years ago. Some tingling in extremities.

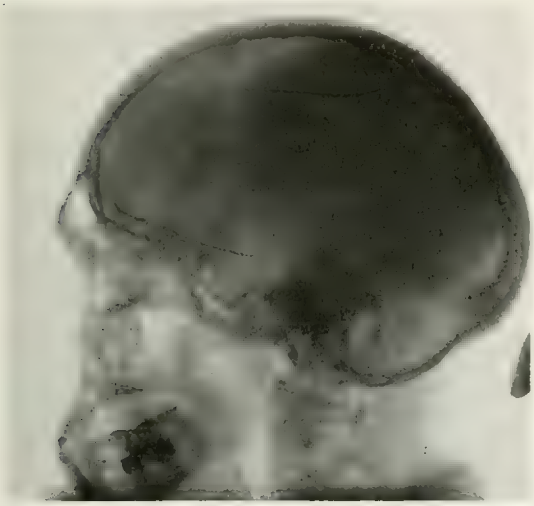


Fig. 2. Case II. Floor of sella extremely thin. Dorsum sella destroyed. Operative findings, cystic adenoma of pituitary.

First seen on August 14, 1920, at which time the sella was reported as being very deep and large, the floor and the clinoid processes not easily made out. From the roentgen findings, a tumor of the hypophysis was suggested at this time.

The patient was told to return for further examination, but did not do this until March, 1921, at which time the dorsum sella was completely destroyed. The floor of the sella was extremely thin and some encroachment on the sphenoidal sinus was noted. A roentgen diagnosis of hypophysial tumor was made.

Dr. Stone reported the following ocular findings: "Bitemporal hemianopsia. Central vision 20/30 20/50. Slight pallor of both nerve heads. Both well outlined. No choking. Terminal vessels tortuous."

Patient was referred to Dr. George Heuer of Baltimore, who operated early in April, 1921, exposing the chiasmal region by an intracranial approach. His report follows: "We immediately exposed a very large hypophysial cyst which had extended upward and directly compressed both the optic chiasm and the mesial surfaces of both optic nerves. We evacuated the cyst, which contained a bloody grumous material such as we usually find in degenerated adenomata of the hypophysis. We removed a large part of the cyst wall. Since operation the patient has done well and states that his headaches have disappeared and his vision is improved."

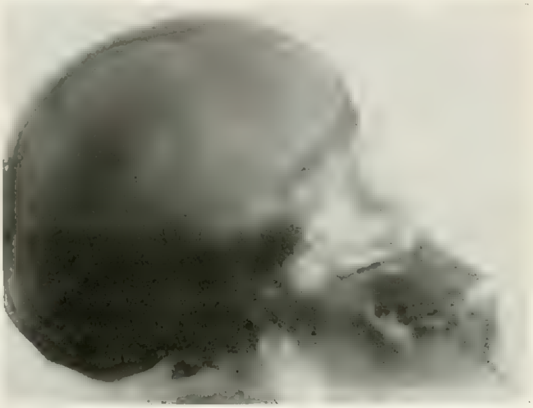


Fig. 3. Case III. Acromegaly. Extremely large sella. No destruction or thinning of floor. Large frontal sinus and inferior maxilla.

Case III. Male, aged thirty-six. Illustrates the typical roentgen picture found in the secretory disturbances of the sella in the acromegaly type. Extremely large deep sella, with no destruction or thinning of the floor. Large frontal sinus, and large protruding inferior maxilla.

BIBLIOGRAPHY

1. Frazier, C. H. Effects of radium emanations upon brain tumors. *Surg., Gynec. & Obst.*, 1920, xxxi, 236.
2. Ibid. Lesions of the hypophysis from the viewpoint of the surgeon. *Surg., Gynec. & Obst.*, Dec., 1913, p. 724.

3. Ibid. Choice of method in operations upon the pituitary body. *Surg., Gynec. & Obst.*, July, 1919, p. 9.
4. Frazier, C. H. and Lloyd, J. H. A case of tumor of the hypophysis. *J. Am. M. Ass'n.*, Nov. 1, 1913, lxi, 1626.
5. Johnston, Geo. C. Roentgen observations of the pituitary region in intracranial lesions. Am. J. Roentgenol., Nov., 1917, iv, 555.
6. Luger, Alfred. Zur Kenntnis der im Röntgenbild sichtbaren Hirntumoren mit besonderer Berücksichtigung der Hypophysengangsgeschwülste. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1913–1914, p. 607.
7. Strubell, A. Zur Röntgendiagnose der Hirntumoren der Hypophysengegend. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1914–1915, p. 389.
8. De Schweinitz and Halloway. A clinical communication on certain visual-field defects in hypophysis disease, with special reference to scotomas. *J. Am. M. Assn.*, 1912, lix, 1041.
9. Rönne. Gesichtsfeldsstudien über das Verhältnis zwischen der peripheren Sehschärfe und dem Farbensinn, speziell die Bedeutung derselben für die Prognose der Sehnervenatrophie. *Klin. Monatsbl. f. Augenh.*, 1910, N. F., bd. x, s. 455.
10. Cushing, Harvey. The Pituitary Body and its Disorders. Philadelphia, 1912, Case xviii, p. 108.
11. Ibid. Accessory sinus disease and choked disc. *J. Am. M. Assn.*, July, 1920, lxxv, p. 236.
12. Cushing, H. and Heuer, G. J. Distortions of the visual fields in cases of brain tumor. *Johns Hopkins Hosp. Bull.*, 1911, xxii, p. 190.
13. Walker, Clifford B., and Cushing, Harvey. Distortions of the visual field in cases of brain tumor, chiasmal lesions, with especial reference to bitemporal hemianopsia. *Arch. f. Ophth.* Fourth paper, Brain, Parts III and IV, March, 1915, xxxvii.
14. Ibid. Distortions of the visual fields in cases of brain tumor, chiasmal lesions with especial reference to homonymous hemianopsia with hypophysial tumor. *Arch. f. Ophth.*, Fifth paper, 1918, xlvii, No. 2.
15. Fisher, J. H. The pituitary body and lesions of the optic chiasm. *Tr. Ophth. Soc. U. Kingdom*, 1911, xxxi, 51.
16. Ibid. Discussions on diseases of the pituitary body. *Proc. Roy. Soc. Med.*, 1913, Vol. vi, Neur. and Ophthal. Sect., p. 53.
17. Ibid. The pituitary body and lesions of the optic chiasm. *Tr. Ophth. Soc., U. Kingdom*, 1911, xxxi, p. 51.
18. Heuer, G. J. and Dandy, W. E. A report of seventy cases of brain tumor. *Johns Hopkins Hosp. Bull.*, 1916, xxix, 306.
19. Ibid. Roentgenography in the localization of brain tumor, based upon a series of one hundred consecutive cases. *Johns Hopkins Hosp. Bull.*, Nov., 1916, p. 311.
20. Giordani, A. J. Diagnostic des Tumeurs de l'Hypophyse par la Radiographie. Paris, 1906.
21. Kohler. Technique de l'Exploration Radiographique de la Selle Turcique pour le Diagnostic des Tumeurs de l'Hypophyse. *J. de Radiol.*, 1909, iii, 5.
22. Benedict, W. L. Early diagnosis of pituitary tumor with ocular phenomena. *Tr. Sect. Ophth. Am. M. Assn.*, 1920.
23. Adson, A. W. Hypophysial tumors through the intradural approach. *J. Am. M. Assn.*, Aug., 1918, lxxi, p. 721.
24. Jaugeas, F. The *x*-ray diagnosis of tumors of the hypophysis. *Arch. Roentg. Ray*, 1910, xv, p. 87.
25. Sachs, E. Review of eight years experience with brain tumors. *Arch. Surg.*, July, 1920, i, 74.
26. Parker, W. R. Visual field findings in case of brain tumor. *Am. J. Ophth.*, Oct., 1920, iii, 736.
27. Jewett, C. Harvey. Teleroentgenography of the sella turcica with observations on one hundred normal cases. Am. J. Roentgenol., July, 1920, vii, 352.
28. Hickey, P. M. Teleroentgenography of the head. Am. J. Roentgenol., Dec., 1919, vi, p. 641.
29. Blumberg. Irradiation of the hypophysis in hypophyseal tumors and in gynecological diseases of hypophyseal origin. *München med. Wchnschr.*, 1922, lxix, 739.
30. Osborne, Sutherland and Scholl. Roentgenography of urinary tract during excretion of sodium iodid. *J. Am. M. Assn.*, Feb. 10, 1923, lxxx, No. 6, p. 368.
31. Enfield, C. D. The normal sella. *J. Am. M. Assn.*, Sept. 16, 1922, lxxix, No. 12, p. 934.

IMPORTANCE OF THE ROENTGEN EXAMINATION IN THE DETERMINATION OF THE PROPER METHOD OF TREATMENT OF PULMONARY ABSCESS*

BY W. H. STEWART, M.D.

NEW YORK CITY

THE author ventures to state that the clearest and best method of ascertaining the size and location as well as the extent of involvement of the lung in all cases of pulmonary abscess, is by the roentgen examination. One can, from these findings, combined with the bronchoscopic and clinical investigations, determine the proper theraputic course to pursue.

The three recognized methods of treatment of abscess of the lung, whether single or multiple, are:

1. Expectant
2. Bronchoscopic
3. Surgical

While there is no question that a certain percentage of cases of pulmonary abscess recover spontaneously, the author is firmly convinced that one should not wait for the possibility of such an event.

Bronchoscopic treatment should be commenced just as soon as the lesion is discovered. The establishment of free drainage is an immediate indication, even though the patient have acute general manifestations; in many acute cases the simple procedure of clearing out the bronchi by suction and the opening up of the swollen and edematous branch bronchus leading to the abscess is sufficient to start resolution. More difficult cases require injection of solution of silver salts such as colline or silver nitrate. Should the process be resistant to the ordinary bronchoscopic methods, direct injections into the abscess of subcarbonate of bismuth held in suspension in sterile sweet oil can be resorted to.

It is important to check up the bronchoscopic evidence of improvement or otherwise by frequent roentgenographic examinations. No case of lung abscess is considered entirely cured until every roentgenographic sign of the lesion has disappeared. I have frequently observed that many patients, although symptom-free and gaining in weight, still show *x*-ray evidence of the process and are in danger of a "flare up."

Except in cases where hemorrhage is a complication—when instrumentation is contraindicated—pulmonary suppurations consisting of small or medium-sized abscesses located in the lower portion of the upper lobe or in the middle or lower lobes, with a moderate amount of infiltration surrounding the cavitation, seem to respond best to bronchoscopic treatment. The percentage of success in this method is largely controlled by the skill of the operator; some men are able to drain an abscess even when it is located well up in the apex.

Multiple lung abscesses or bronchiectatic cavities do not respond well to bronchoscopic treatment, and cases of pulmonary abscess complicated by a general or a sacculated empyema are entirely out of the field of the bronchoscopist.

Surgical attention is indicated in most cases of lung abscess in which there is a large amount of induration with a small amount of softening, especially if the lesion be located in the upper lobes.

Very often in cases of sacculated empyema secondary to a pulmonary abscess—and most of them are secondary—the visceral pleura has been partially or totally destroyed; this means that the case is one of pleuropulmonary abscess which can be relieved only by surgical measures. Chronic pulmonary abscesses with well-formed pyogenic membranes and rigid walls also require surgical attention.

In border-line cases the question of when bronchoscopic treatment ends and when surgery begins is a debatable one. As a rule, surgery should be resorted to if the lesion shows no improvement while under the care of the bronchoscopist for a period of six months. One case in my series received bronchoscopic treatment weekly for almost a year, with final recovery.

---

* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

It is not within the scope of this paper to deal with the different surgical requirements. It is necessary, however, for the roentgenologist to give the surgeon all the knowledge possible as to the exact location of the abscess or abscesses of the lung. Localizations by means of the *x*-ray, in positions other than the one in which the patient is to be placed on the operating table are not altogether satisfactory.

Regardless of the position in which the patient is placed, the localization must be made during a certain recorded phase of respiration, as the excursion of a pulmonary lesion with the lung during respiration is considerable. One must also be sure that the central ray is directly in the center of the shadow of the abscess, otherwise the localization may be deceiving. In addition, the relation between the abscess and certain easily recognized bony landmarks must be correctly stated. Skin marks are unsatisfactory, as the surgical skin flaps in thoracic work are considerable and the markings are either out of sight or not in correct position at the time they are needed.

The ideal method of localizing a lung abscess is by fluoroscopy in two planes made directly on the operating table, as advocated by Dr. Willis F. Manges of Philadelphia, who employs this technique especially in the localization of foreign bodies in the esophagus and bronchi.

A RELATIVELY LARGE FOREIGN BODY IN THE ORBIT

BY PERCY BROWN, M.D.

PITTSBURGH, PENNSYLVANIA

THE writer is indebted to Dr. H. H. Ainsworth of Madison, Wisconsin, for the opportunity of reporting the following interesting case:

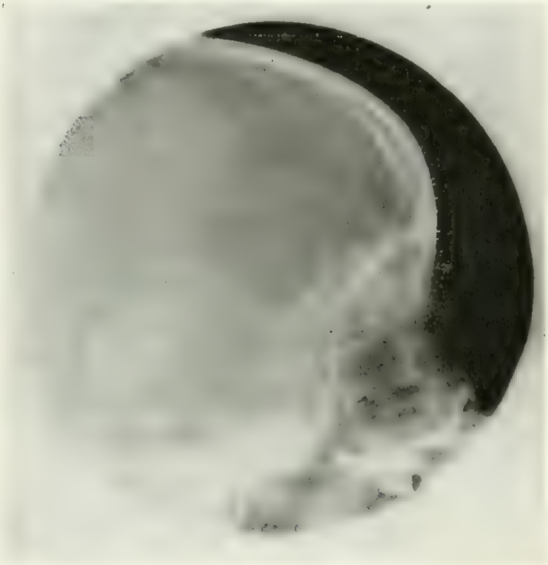


Fig. 1.

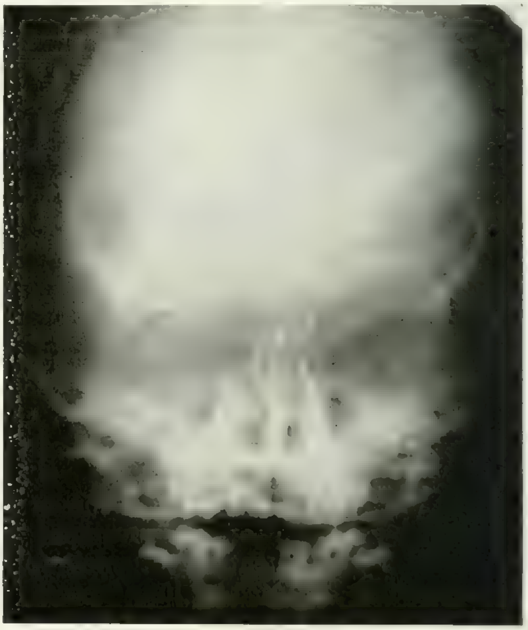


Fig. 2.

A female child, aged two, at play, stumbled over a door-threshold while holding a piece of broken glass. Losing her balance, she fell, driving a sharp corner of the glass through the skin and subcutaneous tissue just above and external to the outer canthus of the right eye. A punctured wound of moderate severity was produced, at the orifice of which no evidence of retained foreign body was presented; neither, on account of the unknown conformation of the large fragment held by the child, could it be determined with exactitude as to whether or not a smaller fragment had been broken off. The case was treated expectantly for three weeks, and at the end of that time was referred to Doctor Ainsworth, as the local symptoms had become augmented by septic infection.

Doctor Ainsworth referred the child for examination to the Section on Roentgenology of the Jackson Clinic. The eye in question presented in moderate degree the local manifestations of infection, with much hemorrhagic injection and lachrymal hyperactivity. Photophobia was much less marked.

After some difficulty, the roentgenographic results as shown in Figures 1 and 2 were obtained. Stereoscopy seemed to be quite out of the question on account of the tender age of the child. The position of the fragment was judged to be in large measure beneath the roof of the orbit but above the globe, and so it proved at operation, with the added disclosure that there were two fragments, one larger by far than the other, as illustrated in Figure 3. This illustration also shows the dimensions of the combined fragments, believed to be extraordinary in that no intimation of these dimensions could be obtained from the appearance of the wound at the time of injury. Moreover, this complete disappearance occurred with no injury to the delicate neighboring structures, save for a very slight wounding of the superior rectus and superior oblique muscles. The patient has made an uninterrupted recovery with no functional loss.

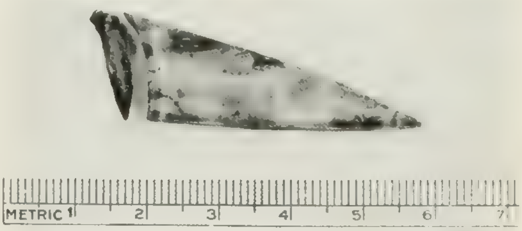


Fig. 3.

FIBRINOUS BRONCHITIS*

BY F. HASE RODENBAUGH, M.D.

SAN FRANCISCO, CALIFORNIA

THE rarity of this lesion, considering the large number of chest examinations and pulmonary infections, and the paucity of literature containing roentgen findings constitute the basis for the report of this rather interesting case.

The diagnosis of fibrinous bronchitis is made from finding long branching bronchial casts in sputum of cases that do not have tuberculosis, diphtheria, pneumonia or some other primary bronchial disease.

In the literature there are less than 100 cases reported, and in but few of these cases are roentgen findings given. Two typical roentgenograms are those of cases described by Walker.

Case I. *Roentgen Findings.* Diffuse peribronchial thickening throughout both lungs. Right apex showed slight mottling and left hilus slightly increased in density.

Case II. *Roentgen Findings.* Entire right chest less radiant than left, with diffuse peribronchial thickening which is more marked on right side. Dense glands at hilus.

CLINICAL HISTORY

A brief history of the present case is quite typical with the majority of case reports:

Case III. Female, aged forty-five years. Occupation, secretary.

Past History. Unimportant; no previous pulmonary, thyroid or cardiac disturbances.

Present Illness. Onset acute with slight rise in temperature (102°F.), severe pulmonary disturbance, moderate leucocytosis with expectoration of bronchial casts.

Convalescence. Uneventful. Four months after onset of illness, patient is clinically well; an occasional small fibrin plug is expectorated.

---

* Paper submitted leading to membership in The American Roentgen Ray Society, 1922.

Roentgen findings during illness and following convalescence from present attack. 1. At onset: Marked increased density about hilus. Increase in bronchial tree markings in both lung fields. Diminished aeration over right lung field.

2. Six weeks: Marked increased density in left hilus over last examination. Diffuse increase in bronchial tree markings extending to lung periphery in left upper lobe.

3. Eight weeks: Left hilus shadow increased in density, less marked than at last examination. Lung fields clearer, but bronchial tree markings in both upper lobes still more marked than normal and extending to periphery.

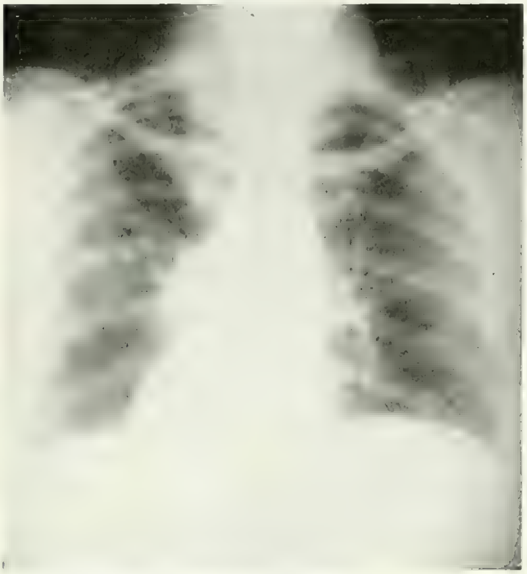


Fig. 1. At onset, Dec. 14, 1921.

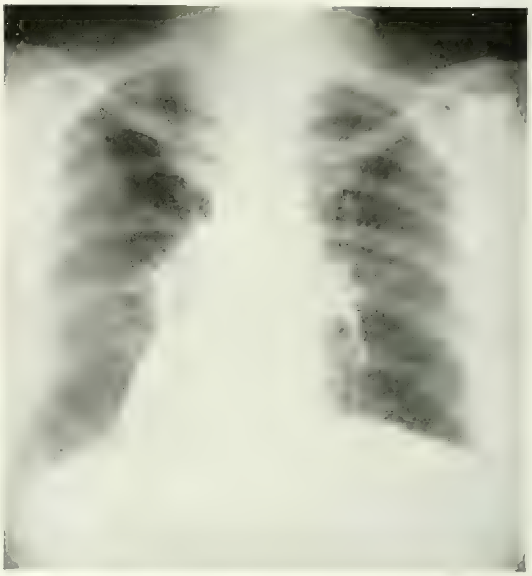


Fig. 2. Six weeks, Jan. 27, 1922.

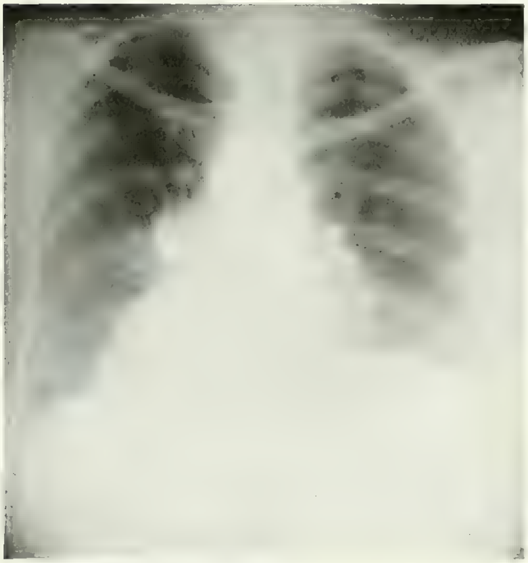


Fig. 3. Eight weeks, Jan. 14, 1922.

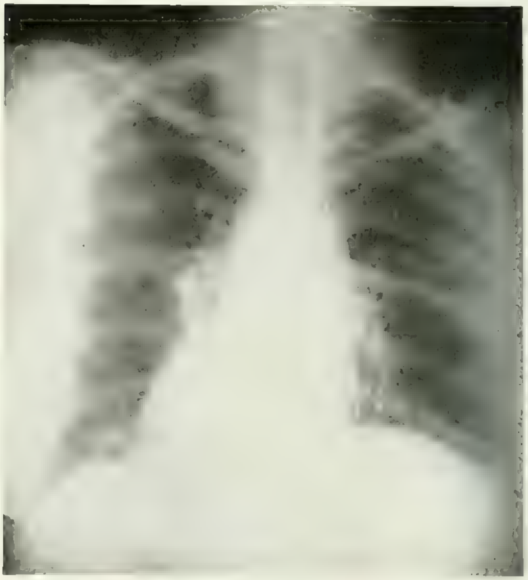


Fig. 4. Four months, Mar. 27, 1922.

4. Four months: Left hilus still showed increased density. Bronchial tree markings still present, particularly over left upper lobe, markedly decreased since last examination.

Differential Diagnosis from Roentgen Findings. The roentgen findings in this case are of considerable interest, as the pathology so closely resembles, in the distribution and character of the lung and hilus densities, certain types of pulmonary neoplasms.

An extensive review of the literature is given by Walker in *The American Journal of the Medical Sciences* for June, 1920, reviewing all cases in the literature to date. A few additional cases have been reported since; however, no additional information as to etiology or pathology has been given.

BOOK REVIEWS

Digestive Disturbances in Infants and Children. By Charles Gilmore Kerley, M.D., and Leon Theodore LeWald, M.D. Contains 84 pages and 49 text illustrations in addition to 54 full-page plates; includes a note on The Surgery of Infants, by William A. Downes, M.D. Price $12. Paul B. Hoeber, Inc., New York, 1923.

The combined experience of a pathologist, a roentgenologist and a pediatrician has produced a volume of unique value for the increase of the understanding of digestive disturbances in children, and consequently for the recognition of the demand for surgical procedures necessary before the small patients have lost so much ground that they become bad risks. The special technique of examining these patients is described, while the interpretation of the findings is facilitated by the generous use of illustrations made from roentgenograms from the authors' own service. The illustrations are clearly labeled, and it is of special interest that "the diagnosis has been verified in nearly every instance by prolonged clinical observation or operation."

The differentiation between pylorospasm and congenital hypertrophic pyloric stenosis is a matter of profound importance. As for the choice of treatment of the former condition, "attention is called to the fact that roentgen examination demonstrates that the Fredet-Rammstedt operation is more desirable from a physiological standpoint, inasmuch as the stomach empties at about a normal rate after the operation; while after a gastroenterostomy it usually empties at a much too rapid rate."

Roentgen examination has also revealed that the frequently severe manifestations of syphilis in the child are often reflected in lesions of the gastrointestinal tract. A recognition of ptosis and of redundant sigmoid in the child puts the physician in a position to save trouble for the patient in later life. The influence of posture on digestion is demonstrated. Among other subjects of interest are hernia of the diaphragm, volvulus, abdominal tumors, tuberculous peritonitis and foreign bodies in the alimentary tract, in regard to which last-named subject the authors have drawn upon Chevalier Jackson's celebrated work.

The book is one which will inevitably appeal to the roentgenologist, upon whom will fall more and more of this sort of work, as its possibilities become better appreciated by the general practitioner and the pediatrist. Uniform with the other volumes in the series of "Annals of Roentgenology," the descriptive text with the illustrations appears in English, French and Spanish. The dedication is a graceful recognition of the work of Dr. Eugene W. Caldwell, "who sacrificed his life in the advancement of the science of Roentgenology." The presswork is in keeping with Mr. Hoeber's high standard.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. IMBODEN, M.D.

Associate Editors: JAMES T. CASE, M.D. H. K. PANCOAST, M.D. WILLIAM DUANE, PH.D.

Publisher: PAUL B. HOEBER, NEW YORK

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

ANNOUNCEMENT OF PLANS FOR THE FUTURE OF THE JOURNAL

In accordance with a decision reached at the Twenty-fourth Annual Meeting of The American Roentgen Ray Society held in Chicago, September 18–21, 1923, The American Journal of Roentgenology and Radium Therapy, with the beginning of the eleventh volume, January, 1924, enters upon a new era in its development. The expansion of the field of roentgenology and radium therapy calls for a larger journal, and beginning with January, 1924, there will be two volumes annually instead of one, and the journal will contain nearly double the amount of material it has had in the past.

The editorship will be in the hands of Dr. Arthur C. Christie, of Washington, D. C., whose object it will be to maintain the high standard of the Journal as in the past, and to enlarge and improve it as much as possible. Particular attention will be given to the abstract department with a view to publishing abstracts of everything worth while in the field of roentgenology and radium therapy. It is hoped, also, that the editorial department will be able to keep the readers of the Journal abreast of the progress in our specialty by reflecting every advance in its development.

Original articles will be published as promptly as possible after their receipt. In choosing articles for publication the needs of the specialist in roentgenology and radium therapy will be considered first, but due to the fact that roentgenology is rapidly taking its place in the daily work of the physician, surgeon and dentist, articles of general interest will also be included.

The Journal is to reflect at all times the present status of radiology in every phase, and whenever possible, to point the way for advance. It will be the effort of the new editor to maintain the traditions of the able editors of the past and to retain for the Journal the high position it has held.

The cooperation of our readers and of all who are interested in the advancement of medical science is earnestly solicited. Contributions, suggestions and criticisms will be welcomed by the editor.

SOUTHERN MEDICAL MEETING

The Radiological Section of the Southern Medical Association will meet in Washington, D. C. on Tuesday and Wednesday afternoons, Nov. 13 and 14, 1923.

On Wednesday evening a joint meeting of the Radiological Section and the Surgical Section of the Southern Medical Association is to be held, at which time there will be a banquet followed by papers on carcinoma of the breast. The presentation for the Radiological Section will be by Dr. George E. Pfahler of Philadelphia. The presentation for the Surgical Section will be by Dr. W. E. Sistrunk of the Mayo Clinic.

All members of The American Roentgen Ray Society and readers of the Journal are invited. We expect to have a well attended and very profitable meeting.

D. Y. Keith, Louisville, Ky., Chairman
W. R. Bethea, Memphis, Tenn., Sec'y.

TRANSLATIONS & ABSTRACTS

Taussig, L. R. The radium treatment of carcinoma of the mouth. *Med. Clin. N. Am.*, 1922, vi, 383.

A large percentage of the cases referred for radium treatment at the present time are the hopeless ones which have been treated unsuccessfully by surgery or in which the seeking of expert advice has been deferred until the possibility of cure has passed. In spite of this, the number of satisfactory results has been encouraging, and soon it will be possible to recognize the class of cases for radiotherapy given alone or in combination with surgery.

The author reports three cases to illustrate the types of mouth malignancy suitable for radium treatment.

One case was that of a man forty years of age who first noticed an ulcer on the right side of his tongue about four months prior to the initial examination. The lesion was a fissure-like ulceration in a hard, nodular mass extending from just in front of the anterior pillar to within about 4 cm. of the tip of the tongue. The palpable induration projected well over the midline. Lues was ruled out by the Wassermann test. The lesion was too extensive for surgery or the actual cautery. The treatment of choice in this case was unscreened tubes of radium emanation.

The tubes were inserted in the malignant tissue rather than in the normal tissue surrounding the malignant area. The true reaction, which consists of a burning pain in the tongue and swelling, usually begins about one week later. The period and intensity of the reaction is variable. If metastatic glands develop it is advisable to remove them surgically if possible. If the condition is not operable, bare tubes of emanation should be inserted.

In the second case the author found a tumor on the inner surface of the left cheek of an upholstery worker about one year ago. The lesion was nodular, hard, about 6 cm. in diameter, and about 1½ cm. high. The glands were 'not palpable. Five bare tubes, totaling 9.5 mc., were inserted into the mass. On account of the suspicious appearance of the tongue, mixed treatment was given for a time under the impression that the carcinoma might have developed on a luetic base. Within a month the reaction subsided and the mass had entirely receded. Two months after treatment a hemorrhage occurred. Five months later an area of increasing thickening was noticed. Additional treatment of four bare tubes was then given. Five months ago a hard nodule developed at the tip of the tongue. Two bare tubes totaling 1 mc. were inserted into the mass. The tongue is still tender but there is no evidence of recurrence at the present time. The author feels that this case has responded well to radiotherapy.

The last case was a nodular, ulcerative, hard lesion of the posterior edge of the soft palate, involving the left side of the uvula. A course of antiluetic therapy given in spite of a negative blood Wassermann had no effect upon the growth. Four bare tubes were then inserted into the tumor. One month later one bare tube was inserted in a suspicious area on the left side of the uvula. Only one week has elapsed since the last treatment, but the entire area feels soft. The cervical region was given a course of *x*-ray treatment soon after the first bare-tube treatment.

Andresen, Albert F. R. Linitis plastica. *Am. J. M. Sc.*, June, 1923, clxv, 799.

The author briefly summarizes the literature of the disease, referring especially to the exhaustive study made by H. M. Lyle in 1911, when he described 131 cases gathered from the literature and added 1 case of his own. Since that time not more than a dozen cases have been reported. [Undoubtedly many cases are now being seen without being reported.]—Ed.

A summary of etiological symptoms and diagnosis is included, including barium meal findings, which are referred to as including the small-sized stomach with marked hypermotility, the barium mixture passing rapidly through the upper abdomen and filling the intestinal coils. The stomach is tube-like, its walls rigid, and there is no evidence of peristaltic waves.

Two cases are reported in full, including one with an hourglass constriction occurring in the course of linitis plastica.

Roentgenograms, photographs and microscopic sections are appended, together with a brief bibliography.

Barclay, A. E. The organization and equipment of an *x*-ray department. *J. Röntg. Soc.*, April, 1923, xix, 55.

This is a very valuable detailed statement of the organization and equipment of a new *x*-ray department for a seven to eight hundred bed general hospital with an extensive outpatient practice. The author, however, has added a description of equipment for smaller hospitals, one of thirty and one of sixty to eighty beds. He emphasizes three very important points, namely:

1. That no elaboration of equipment can

make up for the absence of the first essential—a competent radiologist.

2. Without the provision of adequate facilities the medical officer cannot serve his purpose.

3. That every department must be laid out and equipped with an eye to the work it will be called upon to deal with.

The housing, the requirements, the equipment and the staffing of the department are all discussed in detail, and anyone in need of just the help this article can give will be well repaid by a study of this well-illustrated dissertation.

Halstead, A. E., and Christopher, F. Calcification and ossification of the meninges. *Arch. Surg.*, May, 1923, vi, No. 3, p. 847.

The authors give an elaborate review of calcification and ossification of the meninges, beginning with the first reported instance in man by Antonius Cattus in 1557. The literature is brought down to date. The authors mention that there has been to date no roentgenographic study of calcifications of the meninges. By means of stereoscopic roentgenograms of the skull it is possible to demonstrate calcified plaques in the falx and perhaps even in the parietal dura. A roentgenogram of the head of the cat reveals very plainly diffuse calcification of the falx with the sharp curving inferior border. In the case reported herewith, in which operation was performed by Halstead for tumor of the brain, the roentgen ray revealed shadows which doubtless were due to calcification in the falx.

The authors deduce that ossification and calcification of the meninges are not rare. Areas of ossification may arise from: (*a*) retention of the osteogenetic function by islands of dura; (*b*) an inflammatory process. Areas of calcification may arise as: (*a*) the result of a not far distant absorption of calcium of the skull and its subsequent deposition in the meninges; (*b*) the result of an inflammatory process. In cases of suspected brain tumor, the demonstration by means of the roentgenogram of calcification of the meninges is an additional evidence of the existence of a brain tumor exerting a circumscribed pressure on the skull. The chance finding of ossification or calcification in roentgenograms of the head affords the occasion for an intensive neurologic study of the case in question.

Tarnauceanu. Épreuve de Goetsch et radiothérapie dans les affections du corps thyroide. (Goetsch's test and radiotherapy in diseases of the thyroid). *J. de radiol. et d'électrol.*, 1922, vi. 501.

The author recognizes the importance of some test other than the improvement of symptoms in guiding the radiologist in the treatment of exophthalmic goiter, especially with reference to the time at which each treatment should be suspended. As such a guide the author employed the Goetsch test, which consists of the subcutaneous injection of 0.5 c.c. of adrenalin solution. Tarnauceanu employed 1 c.c. instead of the 0.5 c.c. originally recommended by Goetsch.

In concluding his article the author states that in the objective and functional disturbances which it provokes the Goetsch test gives information regarding hyperfunction or dysfunction of the thyroid gland. It allows the radiologist to make a selection of patients with diseases of the thyroid and to separate those amenable to radiotherapy from those who should be treated by other methods. The Goetsch test is a rational biological test which indicates to the radiologist when the treatment should be stopped. After the completion of radiotherapy the test makes it possible to keep the patient under observation as it must be periodically repeated. It will reveal even the slightest tendency to relapse so that treatment may be renewed before the symptoms become fully apparent.

Charrier, A., and Riou. Malignant Fibrochondroma of the Stomach. *Bull. et mém. Soc. de chir. de Par.*, Mar. 27, 1923, xlix, 488.

The authors report such a case in a male sixty-three years of age. There was complete transformation of the fundus of the stomach into an irregular canal with considerable infiltration of the gastric walls which had lost their elasticity and their mobility, all of which findings were based upon the barium meal. At operation a fibrochondroma of the fundus was found.

Complete histological data are given in the article.

Wesson, M. B. Pyelography: Common diagnostic errors. *Calif. State J. M.*, May, 1923, xxi, 193.

For years it has been taught that the most dangerous person in medicine is the "man with a curette," but he is harmless compared to the "amateur with a cystoscope." Pyelography is ordinarily a simple maneuver. The untoward results are due to a variety of causes, chief of which are: (1) passage of a cystoscope in a very old debilitated patient, (2) ureteral spasms and complete suppression of urine due to the trauma of passing the catheters, (3) use of toxic shadowgraph fluids, and (4) overinjection.

The illustrations show well the futility of attempting to make a diagnosis by a pyelogram alone; a careful history and a systematic urological examination practically always result in an accurate diagnosis.

The article is illustrated by some 47 roentgenograms and photographs of very great practical value.

Fisher, E. B. Experiments on the bactericidal action of the violet ray. *Calif. State J. M.*, May, 1923, xxi, 218.

These experiments seem to indicate that the benefit derived from the violet ray is not from its ability to destroy bacteria but rather its power to increase the number of leucocytes.

Faber. Gastroptosis and the shape of the thorax. *Ugesk. f. Laeger*, May 11, 1922.

Faber finds that the frequency of gastroptosis increases considerably with the degree of deformity and narrowing of the chest. The position of the stomach, as shown by the *x*-rays after a "contrast" meal, and when the patient stands up, may be such that (1) it is entirely above the umbilicus; (2) the lesser curvature is above, the greater below the umbilicus; (3) the lesser curvature is 2 cm. or less below the umbilicus; or (4) it is at least 2 cm. below the umbilicus. The author has devised what he calls the "epigastric index." A line is drawn from the umbilicus to the lower end of the sternum. At the middle point on this line a horizontal line is drawn from one costal arch to the other. The epigastric index is obtained by multiplying the length of this horizontal line by 100 and dividing by the length of the vertical line. The author finds that the average epigastric index is 59.3 for men and 45.4 for nulliparous women. A high index was usually associated with a high position of the stomach among men and nulliparous women. But in parous women there was little relation between the epigastric index and the degree of gastroptosis, which was evidently determined chiefly by childbearing. One of the author's patients was a tall, thin woman with an epigastric index of 30 and the lesser curvature of the stomach several centimeters below the umbilicus. After six years, during which her weight rose from 46 to 80 kg., the lesser curvature was 8 cm. and the greater curvature 3 cm. above the umbilicus.

Crowe, S. J., and **Baylor, J. W.** Benign and malignant growths of the nasopharynx and their treatment with radium. *Arch. Surg.*, Mar., 1923, vi, 429.

The principal object of the article is to report the authors' experiences with the use of radium as a therapeutic agent in nasopharyngeal growths; but also to emphasize the fact that the growth must be recognized early in its development in order to improve our present therapeutic results.

Results with the radium treatment of lymphosarcoma of the nasopharynx are not good, although this variety of sarcoma disappears locally after irradiation more rapidly than does any other type of tumor with which we are familiar. One possible explanation for this unsatisfactory clinical result is that the earliest symptoms of lymphosarcoma in the nasopharynx are difficulty in breathing through the nose and Eustachian tube obstruction, and that these symptoms are usually treated without recognition of the underlying cause until the growth has become diffused throughout the body. The authors believe that it would be a wise precaution to treat with radium every adult patient that has a localized hypertrophy of the lymphoid tissue limited to the nasopharynx, rather than to remove this hypertrophied tissue with a curette.

In this paper little is said about the detailed technique of irradiation. Radium as a therapeutic agent is more dangerous than the roentgen rays, and should be employed only by those who, in addition to their medical education, are thoroughly familiar with physics and higher mathematics. A large clinical experience and a careful correlation of dosage, method of application and result, in the various types of new growths, are essential for the training of a radiologist. For example, it is conceivable that a physician or surgeon, untrained in biophysics, might advise a patient with a localized lymphosarcoma in the throat to have prophylactic irradiation of the mediastinum, abdomen and the glands in the axilla and groin, but a physicist would recognize immediately that such a plan of treatment would result in profound changes in the blood and probably hasten the death of the patient.

The authors discuss polypi, nasopharyngeal fibroma, angiosarcoma (lymphosarcoma, angiosarcoma, myxosarcoma) and cancer.

None of the various types of polypoid growths that occur in the nose or nasopharynx has a rich blood supply, and excessive bleeding following the removal of a polyp always suggests that the primary cause may be a malignant growth instead of an infection.

Irradiation has but little influence on the size or growth of polypoid or myxomatous tissue. The authors have never implanted either radium or its emanations into a nasal polyp: but they have repeatedly irradiated heavily both intranasally and externally without curing the polypoid condition.

In nasopharyngeal fibroma, although the authors' experience has been limited to 4 cases, 2 of these are well and the other 2 are improving.

The treatment consisted of a combination of implantation of emanations, intranasal and external irradiation, and partial removal by operative methods.

For angiomas it is probably deleterious to the best interests of the patient to remove a piece of the growth for microscopic examination, and it is certainly not advisable to attempt the removal of the large nasal growths of this type through the nose. The fact that a piece of the growth had been removed was undoubtedly responsible for the frequent and severe hemorrhages in 4 of the authors' 5 cases that presented this symptom.

With reference to sarcomas, the authors emphasize that every growth removed from the nose and throat should be investigated, grossly and microscopically; but, on the other hand, the diagnosis of such growths should not be based on the microscopic appearance of a small fragment, without taking into consideration all of the clinical and laboratory data that are available. It is doubtful, indeed, whether the removal of a piece of a tumor for diagnosis is ever a justifiable procedure. It is possible, however, that incomplete operative removal or even the removal of a small fragment, either before or during the irradiation, is responsible for the reappearance of the growth in some distant part of the body. If the growth is a very vascular sarcoma or a true angioma, the deleterious effect of a partial removal is apparent in the increased frequency and severity of the hemorrhages. In the majority of the authors' cases of sarcoma, angioma and fibroma bleeding was not a prominent symptom until a portion of the growth had been removed. After the nasal operation, however, the growth becomes infected, and hemorrhages are severe and frequent.

Phemister, D. B. The nature of cranial hyperostosis overlying endothelioma of the meninges. *Arch. Surg.*, Mar., 1923, vi, 554.

This is an extremely interesting study of the local changes in the skull overlying meningeal endothelioma. After a historical summary the author reports 2 cases with photographs, roentgenograms and microscopic sections.

The hyperostosis which develops over a considerable proportion of meningeal endotheliomas results from penetration of the dura and direct invasion of the skull by the tumor. The tumor permeates the skull, rarefies slightly the inner and outer tables and stimulates new bone formation, usually from both the internal and external surfaces. Tumor cells are found in varying numbers throughout the cancellous spaces of the hyperostosis. The new bone is not tumorous in nature, and is merely ossified stroma of the invading endothelioma. Its spongy or radiating arrangement is similar to that which is seen in the ossification occurring in other types of tumor, whether primary or secondary in bone and whether the new bone itself is of tumorous or nontumorous nature.

Vinson, Porter P. Cardiospasm associated with esophageal diverticula. *N. York M. J.*, May 2, 1923, p. 541.

Diverticula of the middle portion of the esophagus have been observed rather often at post-mortem, but rarely have been demonstrated during life. They occur usually in the region of the left bronchus, and are due to healing processes following inflammatory lesions in the periesophageal glands. However, Le Count and Brosch have reported small diverticula of the thoracic esophagus apparently not caused by inflammatory reactions, but by lack of support of the esophageal wall. The contraction of fibrous tissue pulls a small portion of the esophageal wall outward and upward, and produces the so-called traction diverticula. The apices of such diverticula point upward, so that there is no tendency for ingested food and fluid to accumulate in them and increase their size, as is the case in pulsion diverticula.

The author reports 2 cases seen in the Mayo Clinic, in which a pouching of the left side of the middle of the esophagus was found in addition to obstruction at the cardia with the findings typical of cardiospasm.

The mechanism of the formation of these diverticula is, of course, purely speculative. They may have resulted from congenital weakness of the esophageal wall, or they may have had their origin in tiny traction diverticula. In either case they could not have attained considerable size without the spasm at the cardia causing retention in the esophagus, and adding the pulsion force necessary to increase the size of the pouch. It is interesting that neither of the patients had symptoms suggesting that the diverticulum was a factor in the production of the dysphagia. It is possible that the second patient will have food obstruction from the diverticulum at some future time, but if this occurs, food can be given through a stomach-tube which has been guided beyond the sacculation on a previously swallowed silk thread.

Simonetti. Contribution to the study of gastric stimulation by *x*-rays. *Gaz. d. osp.*, Jan. 14, 1923, xliv, No. 4.

The roentgen ray employed in weak doses does not produce a destructive effect such as is commonly employed in therapeutics, but, on the contrary, exercises a stimulating effect upon cellular activity. Under the action of x-rays the total acidity of the gastric juice is constantly increased after ten or twelve such applications. This hyperacidity seems to consist of an increase in the free hydrochloric acid. The pepsin measured in 12 patients after the ingestion of a definite quantity of albumins was found increased in 8 cases, diminished in 3 and unchanged in 1. Clinically this increase of the different components of the gastric juice should be manifested by a return of appetite and more satisfactory digestion of the food. The improvement may come on immediately or some days after the last application.

Rand, Carl W. Osteoma of the skull. *Arch. Surg.*, Mar., 1923, vi, 573.

The author reports 2 cases of osteoma of the skull, one being associated with a large intracranial endothelioma. Numerous roentgenograms and photographs of microscopic sections illustrate this paper.

Reverchon et Worms. Valeur séméiologique de la radiographie dans l'étude de la polysinusite grippale. *Presse méd.*, May 12, 1923, p. 440.

The authors were able during the last winter to study roentgenographically 12 cases of polysinusitis following grippe, both in the acute period and after cure. The series of plates made permitted the authors to follow the ebb and flow of the inflammation which showed a tendency to spontaneous cure as long as drainage was maintained. At the beginning there was a definite shadow, especially in the region of the ethmoid which masked without changing the anatomical outlines. This shadow rapidly extended to the maxillary sinus, then to the frontal sinus and often involved the sphenoid. The sinuses became clear in the inverse order from that in which they became obscured. Transparence reappeared first at the level of the maxillary and frontal sinuses and then in the ethmoidal region, which proved to be the last to return to the normal state.

The information given by roentgenography as to the evolution of a post-influenzal polysinusitis permits a better comprehension of the reasons for temporizing treatment.

De Jong, S. I., and Aubourg. A case of perisigmoiditis verified by roentgen ray study. *Bull. et Mém. Soc. Méd. d. hôp. de Par.* Mar. 22, 1923, No. 10, p. 423.

The authors report in detail, including roentgenograms, the complete story of a case of a plastic sigmoiditis. In this instance the plastic exudate finally was spontaneously re-absorbed without any treatment whatever.

Ashhurts, A. P. C., Bromer, S. R., and White, C. Y. Cystic disease of the bones. *Arch. Surg.*, May, 1923, Vol. vi, 661.

This is a surgical, roentgenological and pathological consideration of cystic disease of the bones based on a study of 15 cases. These cases are carefully narrated, but the article hardly lends itself to abstract.

Maximow, A. A. Changes produced by roentgen rays in inflamed connective tissue. *J. Exper. M.* xxxvii, 319.

Maximow studied the reaction of inflamed tissue, the result of a foreign body, to the roentgen rays. He noted that irradiation produced a considerable depression of the usual reaction on the part of the fibroblasts. They remain idle, do not multiply at all, or start very late and often the division is abnormal. Simultaneously with these changes of the fibroblasts, an intensive edema of the connective tissue surrounding the foreign body is to be noted and in the immediate neighborhood of the latter a thick layer of net-like clotted fibrinous exudate is formed. No distinctive qualitative changes could be found in the leukocytes and polyblasts. The rate and the duration of the emigration of all the cells coming from the blood were increased, and there was always a distinct delay in the process of the common transformations usually undergone by the polyblasts on the field of inflammation. The transformation of the polyblasts into fixed resting forms seems, above all, to be delayed. In the blood-vessels swelling of the endothelial cells, with fragmentation of the nuclei, and, in the striated muscles, degeneration of the fibers can be detected. In the latter there occur partly typical coagulation necrosis, partly atrophy, accompanied by loss of striation, separation of fibrillae from one another, relative increase of sarcoplasm, and amitotic division of nuclei. These results seem not to agree with the predominating views on the action of roentgen rays on cells.

Symonds, C. Gonorrheal stricture of the rectum. *Proc. Roy. Soc. Med.*, 1923, xvi, 13. Sect. Surg.

This type of stricture involves the lower 8 or 10 cm. of the rectum, including the anal margin and the entire circumference of the bowel. The bowel shows bands and bridles of indurated muscle separated by pockets, from the bottom of which fistulous tracts lead into the vagina or to the surface around the anus. In advanced cases it is not possible to make a digital examination because of the extreme narrowing which occurs.

All 7 of the cases reported by the author occurred in women. In searching the museums he was able to find 38 other specimens, many of these being labeled "syphilitic in origin." It is entirely probable that many cases of syphilis of the rectum are in reality gonorrheal in origin.

Colostomy is the principal indication with cecostomy or appendicostomy as a substitute in certain cases. It is dangerous to attempt dilatation because the use of bougies or division of the stricture is likely to produce a perforation. Excision can seldom be performed except when the disease is very early.

Rhormley, R. K. A case of congenital osteosclerosis. *Johns Hopkins Hosp. Bull.*, 1922, xxxiii, 444.

The author first carefully reviews the literature, noting that the condition described had not been reported as diagnosed during life in any case. Several cases were diagnosed at autopsy.

In the author's case the diagnosis was first considered as a beginning epiphyseal separation of the head of the left femur. Roentgenographic study of the pelvis showed a peculiar density of the bones, and a later study of all the bones revealed practically the same condition throughout the entire skeleton; the vertebral bodies even showed marked density at both poles; the ribs showed thickening of the cortex of the bones, especially in the distal portion of the long bones; the skull was thickened. In the neck of the femur on both sides, especially in the left side, there seemed to be a destruction of the bone just below the peiphysis. The condition was proved to be congenital by a study of the father's bones, which were exactly like those of the child. The mother's bones were shown to be roentgenologically normal.

Baldwin, W. M. A study of the combined action of *x*-rays and of vital stains upon paramaceia. *Biol. Bull.*, 1920, T. xxxix. 59.

The author has made use of a certain number of vital colors, Nile blue, alizarin blue, trypan blue, isamin blue, dahlia and other colors. The author also employed the *x*-rays and has observed the successive action of the colors and of the *x*-rays. While the quantity of energy necessary to inhibit the activity of the non-colored paramecia varied from 60 to 80 ma. minutes under the conditions of the experiment, on the other hand, with the colored infusoria, for example, those colored with trypan blue, the same result was attained in 5 to 10 ma. minutes. There are, nevertheless, considerable variations within certain limits in the sensibility of the various cultures to the energy of the *x*-rays and also in the rapidity with which they absorb the colors. The direct application of *x*-rays upon the colors themselves did not seem to modify their action upon the infusoria.

Schinz, H. R. Human castration by the *x*-ray (Ein Beitrag zur Roentgen-Kastration beim Mann). *Schweiz. med. Wchnschr.*, 1922, lii, 866.

After reciting a case in which castration was performed in a man by means of the *x*-ray, the author describes the physiological effects of the dose given and makes the following suggestions regarding the determination of the dose and the clinical signs upon which the size of the dose should be based:

1. Temporary sterilization with clinical oligonecrospermia. Necessary dose, at least 34 per cent of the skin unit dose in the male; 30 per cent in the female.
2. Total permanent aspermatogenesis. Dosage, about 60 per cent of skin unit dose in the male; in the female with Wintz exovulation, 32 per cent.
3. Total castration with destruction of all the constituent elements of the testicle. Dose for male not yet determined; for the female, 34 per cent of the skin unit dose.

Bierman, M. I. and Jones, W. M. A Third Omentum. *Surg., Gynec. & Obst.*, May, 1923, xxxvi, 641.

The authors have chanced upon 2 cases, in each of which there was an additional omentum much like the greater omentum; but instead of being dependent from the transverse colon it was dependent from the lesser curvature of the stomach. At operaton no pathological conditions of any kind were found in the upper half of the abdomen. The additional loop of omentum, therefore, was not the result of an inflammatory condition in which there had been a separation of omentum in an attempt to localize an inflammatory process, but appeared to be a distinct developmental variation.

A semi-diagrammatic sketch is appended of one of the case reports where this third omentum extended from pylorus to cardia, being triangular in shape, and its length almost half that of the circumference of the stomach. The omentum was curled up during the roentgen examination and produced a constant defect on the lesser curvature. When found, it was still partly folded up but was straightened out without any difficulty. Such a possibility should be borne in mind by every roentgen diagnostician.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X NOVEMBER, 1923 No. 11

THE USE OF RADIUM IN THE TREATMENT OF THE LEUCEMIAS AND HODGKIN'S DISEASE*

BY W. H. B. AIKINS, M.D.

The Radium Institute

TORONTO, CANADA

When we begin the consideration of the leucemias we enter the realm of empiricism. We have excellent clinical evidence of the beneficial influence of radium in these conditions, but our research work has, so far, offered us no good reason for it. Levin has shown that in a frog the lymphocytes are the first to show the effects of radium and *x*-rays. This seems to be true also in man. Other types of leucocytes, as well as the erythrocytes, exhibit a greater resistance, but the pathological cells, such as the myelocytes, seem to be easily destroyed and thus are similar to the cells found in neoplasms. This is another argument for the theory that leucemias are really neoplasms of the blood. It is worthy of note that the lymphocytes in lymphatic leucemia are destroyed "a great deal more rapidly than the identical morphological lymphocytes in conditions of inflammatory leucocytosis" (Levin[1]).

Splenic Leucemia. In no other fatal disease can we do so much with radium as in the treatment of splenic leucemia. One can promise almost with certainty that a remission will follow the first application. Sometimes within twenty-four hours the general condition of the patient improves; for example, he regains his appetite and his sleep. The blood picture is changed for the better in a few days, the white count dropping so quickly on a few occasions, that the application of the radium had to be stopped. Last of all the spleen recedes, generally to the rib margin, seldom farther. This can best be illustrated by the following histories:

Case 3201. Male, forty-nine years of age, a car inspector. Had been in failing health for a year or more. He was a stout, red-faced man, weighing 190, but reported to his physician because he tired before the end of the day. The enlarged spleen, almost in the pelvis, and the white blood count of 416,000 myelocytes, 67 per cent, made the diagnosis. Radium in flat applicators was given, 2750 mgm. hours in all. In twenty-four hours the abdominal distress which had been present for some months was markedly less, his appetite returned, and he was able to sleep. In two days his white count dropped to 256,000, and in four days his spleen was 2 in. smaller. A week later he returned to work and has been in good health for four months.

Case 1106. Female, aged thirty-one. Had been losing weight for about a year. In March, 1917, was noticed enlargement of the spleen and the blood count showed leucemia. In July, 1917, she received radium treatment and improved to such an extent that she was able to resume ordinary duties. In December she experienced loss of strength, and was given further treatment in February, 1918.

---

* Read at the Eighth Annual Meeting of the The American Radium Society, San Francisco, Calif., June 25–26, 1923.

This was repeated in August and November, each treatment restoring a certain amount of her former strength. In March of the following year, also, she received radiation, but after this treatment she did not rally. She gradually sank, and died in July, 1919, two years after treatment with radium had been begun.

CASE 2020. Male. Came to us in June, 1920. He had experienced weakness since the previous December, and enlargement of the spleen was first noticed in May, 1920. When seen in June the spleen extended 2 in. beyond the umbilicus, there was slight epistaxis, and the patient was thinner than normal; the red blood count was 3,904,000 and the white count 333,500. At the end of the first radiation, five days later, the reds had increased to 4,128,000 and the whites were down to 236,000. Radiations were given at varying intervals until February of this year. After each radiation the white count was markedly reduced. When last seen the count was down to 62,000. The disease is still being most satisfactorily held in check.

These cases illustrate the extraordinarily rapid and powerful effect of radium in leucemia. Unfortunately the improvement is not permanent, and within a few months there is a relapse, which, however, yields again to radiation. In order to hold the patient at the maximum of improvement, the spleen has, in certain cases, been excised after treatment with radium. But the relapse comes as certainly, in spite of the operation, so that this surgical measure is not to be recommended.

Our experience with leucemia has been that of several others. Gulland of Edinburgh[2] finds that radium is not suited to the treatment of lymphatic leucemia, but that the most favorable form for this treatment is chronic splenic leucemia. He had been treating the latter condition with *x*-rays, but, as he was not getting satisfactory results, he tried the effect of radium. The results were not more permanent, but were more certain and rapid, and he considers that patients improve more in general condition and in recovering from their anemia. Bonta[3] reports the results of radiation in the chronic types of leucemia in which he obtains marked improvement in the general condition and rapid reduction of the spleen or enlarged lymph-nodes. These results also are corroborated by Stern,[4] who states that of the leucemic diseases the most satisfactory response to radium is found in chronic myelogenous leucemia.

The method of application in this condition is of the utmost importance. It has been shown experimentally that the larger the square surface of the entry of radium or *x*-rays into the organism, the more severe is the general effect upon the blood. In the leucemias we desire this destructive action, so we use large, flat applicators in preference to tubes. These are backed by metal so that the total amount of rays entering the body is much more than would be charted in milligram hours. Each of these plaques is well screened and applied over the spleen long enough in each position to produce an erythema. By marking off the spleen area into squares of the size of the applicator, we are able to give from 2,500 to 4,000 mgm. hours at each seance. The intervals of treatment will depend upon the condition of the patient.

In a few cases the constitutional symptoms, such as nausea, vomiting and diarrhea, were pronounced after these large doses, but they passed off in a few days. The urgency of treatment is uppermost and these minor details may be disregarded.

Since we have adopted this method of treatment we have had the satisfaction of giving all of these doomed patients some respite from their worst symptoms. The "life-history" of the disease is so variable that it is mere conjecture to say that their days have been prolonged. Some of these patients have a chronic form of the malady, and have lived five years or more without any treatment. But one cannot resist the impression that life was made comfortable and was probably prolonged by radium treatment.

Lymphatic Leucemia. When we come to consider lymphatic leucemia and those conditions which seem to be a mixture of the two leucemias we are not able to hold out the same prospects. It is true that many cases of lymphatic leucemia are improved by radium, but the enlarged glands are usually so scattered over the body that it is difficult to apply a sufficient dose of the gamma rays, and so we cannot promise the same remission as in splenic leucemia. But the white count will be markedly reduced, and sometimes the lymphatic glands return to normal size. As in splenic leucemia the general condition is improved for a time, and one feels that it has been worth while.

Gulland[2] reports satisfactory results in the radium treatment of Banti's disease. The spleen became smaller, and the patients improved so much that splenectomy was not required.

Hodgkin's Disease. This may be successfully treated with radium. There are no characteristic changes in the blood picture, the only guides to improvement being the size of the enlarged glands and the general condition of the patient.

According to Ewing[5] the initial symptom in Hodgkin's disease is an enlargement of a chain of lymph-nodes, cervical (50 per cent), axillary, or inguinal, and the continuous or irregular extension to other chains. He states that a splenic tumor develops in 60 to 70 per cent of the cases, and that there is frequently enlargement of the liver. With such generalization of the disease, fever, night sweats, anemia, and cachexia appear.

The diagnosis of Hodgkin's disease is, however, difficult. It is no easy matter to distinguish between sarcoma and Hodgkin's disease. The interrelation between the two has been discussed by a number of writers. Mueller[6] reports 2 very interesting cases, one of which was ascertained by biopsy to be Hodgkin's disease, but on autopsy was found microscopically to have been changed into round-cell sarcoma. The second case was one which presented, clinically, symptoms of a mediastinal tumor of moderate size without the usual multiple enlargement of the lymph-nodes of the neck, axillae and groins, except for a single moderately swollen node in the left side of the neck. Radiation had no effect on the tumors, and biopsy left the diagnosis between round-cell sarcoma and lymphogranuloma, autopsy confirming the latter diagnosis. From these two cases Mueller concluded that lymphogranuloma (Hodgkin's disease) and round-cell sarcoma of the lymph-nodes are only different expressions of the same process. This view is supported by similar reports from Yamasaki, Karsner and Welch.

Burnam[7] points out the close resemblance between lymphosarcoma and Hodgkin's disease. Of cases which were definitely lymphosarcoma, 2 had remained well with no recurrence for more than five years, and 4 had not recurred after three years; of cases which were definitely Hodgkin's disease, 1 had been well for four years, and 2 had shown no recurrence after three years. In concluding his paper he states that, while there is no objection to complete surgical removal of a localized group of glands in these diseases, if such procedure is followed by radiation, his results lead him to believe that surgery is quite unnecessary.

The following histories of cases of Hodgkin's disease which I have treated give ample evidence of the value of radium in this condition:

Case 2453. Male, aged thirty-three. First noticed enlargement under the left jaw in 1917. The mass had not increased much in size in May, 1921. At that time there was a glandular development about the size of a small hen's egg below the left maxilla, and the patient had been advised several times to have it removed surgically. A second gland about the size of a hazel-nut was attached beneath the chin close to the middle line. There was also a chain of enlarged glands just above the sternoclavicular articulation about the size of a hazel-nut. No involvement in the axillae could be detected, and the spleen was normal in size. Throughout the course of treatment marked decrease in the size of the abnormal glands was noted. In April, 1923, his condition was excellent. We considered him a sufficiently good risk to take out an insurance policy at a slightly increased premium. However, it is interesting to note that when the policy was issued the premium attached was a normal one. There still remains a slight enlargement of the chain of glands on the left side of the neck. No glands are palpable in the axillae or groins, and the spleen is normal in size and position.

Case 2057. Male, aged thirty-four. Reported to me for treatment on July 8,

1920. He had an enlargement about the size of a small egg on the left side of the neck. It had been first noted two years previously. He had tried "blistering" with no beneficial effect. The cervical glands also were involved. He was given deep radium exposures every month for five months, after which time the size of the enlarged glands had diminished markedly and there was no evident involvement above the clavicle. His treatment was suspended. He returned seven months later with small glandular involvement over the left side of the neck. This was given a heavy radiation, the last exposure being in August, 1921. He did not return until April of this year, having remained free of symptoms during that time. There is now a development above the right clavicle, which we are treating. Radium has been most beneficial in holding the disease in check.

Case 2303. Male, aged thirty-six. Came to me in December, 1920. Four years before this date he had been operated on and glandular tissue from the cervical region had been removed. About one year later recurrence had commenced, first at the angle of the jaw, and later above the clavicle. Enlarged glands were present in the axilla when first examined. There was no enlargement of the spleen. His general health was fair. Radium treatment was given at six-week intervals, and has been continued. He has shown gradual but definite improvement, and might now be considered clinically cured. It is essential, of course, that he keep in close touch with his physician so that any recurrence may be treated immediately.

BIBLIOGRAPHY

1. Levin, I. Action of radium and the *x*-rays on the blood and blood-forming organs. Am. J. Roentgenol., Feb. 1922, ix, 112.
2. Gulland. Discussion on radiation in the treatment of diseases of the blood. *B. M. J.*, Aug. 20, 1921.
3. Bonta. Radium in the treatment of leukemia. *Ann. Clin. Med.*, Nov., 1922.
4. Stern. Radium in the treatment of blood diseases. *J. Mich. M. Soc*, Aug., 1922.
5. Ewing, J. Neoplastic Diseases. Philadelphia, 1919, p. 353.
6. Mueller. Relation of Hodgkin's disease to sarcoma. *J. Med. Research*, 1920–21, p. 325.
7. Burnam. The treatment of Hodgkin's disease. *Surg., Gynec. & Obst.*, May, 1919.

DISCUSSION

Dr. H. H. Bowing, Rochester, Minn. This is a very interesting paper, in that the primary result in practically all patients in the group described is rapid. In some instances the amount of local reduction in the tumor is astonishing. The leucemias, Hodgkin's disease, and lymphosarcoma can be classed under one head as blood dyscrasias. If I understood Dr. Aikins, he uses the flat applicator to the point of producing erythema. In some of the early cases treated in the Mayo Clinic, as reported by Dr. Giffin, in 1917, the erythema was believed to be necessary. It was first attributed to the adhesive plaster used. Then an applicator was devised, including a wood plaque with holes to fit the radium tubes and a lead plaque, 2 mm. thick; this was fastened to a leather piece or belt. It produced a first-degree erythema in most patients, and a second-degree in a few. The healing in all cases was usually prompt and in many the telangiectasia appeared, with the ordinary skin changes in an area the size of the applicator. The belt was soon discarded since the distance it furnished was not sufficient. Our present applicator contains a 50-mgm. universal tube of radium, silver walls 0.5 mm. thick, filtered through 2 mm. of lead and maintained at 2.5 cm. distance, the time of application varying from three to eight hours to each area. The same purpose is accomplished without injury to the skin. If the general condition of the patient is good and the history long standing, the 50-mgm. tube is applied and worn for twenty-four hours. If the spleen is large, the skin surfaces overlying four areas are given six hours each. If it is small, eight hours each are given to three areas. If there is marked weakness and secondary anemia with the ordinary blood changes with a high leucocyte count, applications are made more cautiously, the 50 mg. tube, screened as mentioned, being worn for only twelve hours instead of twenty-four. We usually see some reduction in the leucocyte count and some improvement in the condition following the second or third treatment. As long as the leucocyte count goes down and the other blood factors remain as at the time of the first treatment, we continue until three or four have been given. When the erythrocyte count and hemoglobin decrease, the treatment is stopped immediately for fear of increasing the anemia. The interval is usually a week, and at the end of five days a blood count is made to determine whether radium shall be applied again. If delayed, it is usually a month or six weeks.

In cases of myelogenous leucemia patients are supported with roentgen treatment over the long bones, with the hope of securing benefit by further reduction in the myelocytes circulating in the blood.

In lymphatic leucemia with the multiple enlarged glands, it is our rule to distribute the radium, usually employing eight areas, giving three hours for each area; two in the right and left cervical areas, one each in the axillary, one each in the inguinal spaces. With this technique we have seen no skin reactions, and the patients improve. It is usually an index of a favorable change in the blood. As long as patients report that they are feeling better, resting more, their appetite returning, and so on, it is safe to continue the treatment until four have been given, with a subsequent rest of from six to eight weeks. As a group, these patients are very grateful; the initial response is satisfactory and in some quite enduring.

Dr. Laurence Taussig, San Francisco, Calif. From the dermatologists' viewpoint Dr. Bowing's point is well taken. We should avoid causing reaction on account of the possibility of subsequent atrophy and telangiectasia. It makes no cosmetic difference over the spleen but it increases the sensibility of the skin over the area treated and is likely to hinder one in the further treatment of a case.

Dr. Grace L. Homman, LaPorte, Ind. I had a case that ran over 900,000 lymphocytes per cubic millimeter. I do not remember the exact count. Cases have been reported with counts over 1,000,000.

I should like to ask Dr. Bowing why he uses 2 mm. of lead in his screen. My impression is that all one needs is the one-inch distance. The beta rays penetrate only two or three millimeters of tissue and therefore the lead screen seems to me unnecessary.

Dr. Edwin C. Ernst, St. Louis, Mo. My experience in the radiation of these conditions has been largely limited to the use of the *x*-ray rather than radium. Those cases in which radium was employed exclusively did not react satisfactorily; the dosages employed were no doubt too severe. Therefore, our experience with radium has been too limited to be of value in this discussion.

However, 14 or 15 cases of myelogenous leucemia, in which there had been a return of the splenic enlargements, together with a return of the original blood pictures, a type of cases very unfavorable, after having received a series of *x*-ray treatments, did respond to the second series of radiations. We did not attempt to force the treatments, employing extremely mild dosages of *x*-rays. The amount of radiation at times did not seem sufficient to produce any cellular changes. Nevertheless, we believe that the treatment of these conditions warrants mild but repeated exposures. The above series of cases had a return of symptoms. This was due entirely to the fact that they failed to appear for further treatment, contrary to our instructions to report regularly at certain prescribed intervals.

All of the above patients are in comparatively good health, symptom-free, for periods ranging from two to five years. Those patients in whom more intensive radiations were employed, failed to respond in an equally favorable manner. The technique employed ranged from 135,000 to 140,000 volts, sphere-gap measurements, employing a filtration of 4 mm. of aluminum at a focal skin distance of from 10 to 12 in. The time factor was frequently as low as 15 ma. minutes over each area. This amount of radiation was employed directly over the splenic area at long intervals, the long bones receiving the more intensive radiation. The intervals between treatments were gradually increased. Most important of all, we did not attempt to reduce the white cell count too rapidly.

Dr. Sanford Withers, Denver, Colo. Has Dr. Aikins ever estimated the greatest possible number of lymphocytes that might be in a cubic millimeter? I had a case of lymphatic leucemia that came in with a count of 860,000 per cubic millimeter. According to my calculations a cubic millimeter of blood should not be able to hold more than 1,200,000 and I should like to hear if anyone else has had a case of lymphatic leucemia with such a high count.

Dr. William E. Montgomery, Kansas City, Mo. I wish to report a case of myelogenous type treated by the old method. The patient is now living and has had no treatment for eight years. The last blood count showed 20,000 white cells. He still has a lemon color and is not very robust but is able to attend to his business. All the other cases I have treated are dead. I thought this case was a little out of the ordinary.

Dr. R. E. Loucks, Detroit, Mich. I have been interested in this condition for some time. It was my misfortune to treat a medical friend who had a myelogenous leucemia. The first intimation was a hemorrhage in his eye and we found splenomyelogenous leucemia. He was very much alarmed. He had some experience with the *x*-ray and did not have much faith in it. He came into our service and we treated him for five or six years. He improved greatly and was quite well during that time, continuing his practice. He did not exactly follow the rules we laid down, but ate what he wanted and drank what he could get, so it was hard to keep him under control, but we made him very comfortable for five or six years. Then the spleen was so large that radium did not seem to have much influence on it, so I turned him over to Dr. Stevens and we rayed the long bones for about a year, but did not get much reduction in the size of the spleen or white count. He lived for about six years and died of a terminal pneumonia.

I have another case that has been under observation for four or five years. After his first treatment he was very well for about a year. One night he had a vomiting spell with terrific hemorrhage. He became greatly exsanguinated and we had to do a transfusion immediately. We applied radium later and he picked up quickly. We treated him again two months ago but now his spleen fills the entire abdominal cavity and is becoming hard. His white blood count is something like 600,000 and we do not expect to get much result from treatment.

I have never seen much benefit from the treatment of the long bones with *x*-rays. It has been advocated for some years and I think all of us have tried it, but I have never had as good results from the *x*-rays as from radium. I have used 200 mgm. over the different areas and have given them as much as twenty hours, distributed over five different areas. It does give the patients a lease on life and probably we can do as much for them with radium as with anything else.

Dr. H. H. Bowing, Rochester, Minn. Answering Dr. Homman's query as to the 2 mm. of lead, I have often questioned its use in this formula, but I know that wherever a number of areas confined to a small space are treated, the use of lead is essential, to avoid an erythema. It requires so little radium and time of application to bring about the desired result, that I have never seriously questioned removing the lead from the applicator.

Concerning the blood count of 1,000,000 or more, I do not recall a case in which the leucocytes reached a million. The largest count I can remember was 700,000 and the response was gradual, although the reduction was greater each week and more rapid.

Concerning splenectomy as a procedure in the management of these cases, I do not care to make any statements, since I am not familiar with the studies now in preparation at the clinic. It has been my privilege to treat splenectomized patients. The hepatic area is exposed to small quantities of radium. The reduction in the blood count occurs, but the liver does not reduce in size. A case has been reported in the literature in which the spleen was removed, and the splenic area treated, with good results.

Dr. Henry Schmitz, Chicago, Ill. In a series conducted with Drs. Ochsner and Percy we used about 100 mgm. radium element over the spleen for fifty hours divided over six fields at a distance of 3 cm. Within fourteen days the spleen was reduced to normal size and the white blood count was usually from 15,000 to 30,000. In some cases the improvement would last from three to six months, when reapplications of radium had to be made. However, with each subsequent course of radiation the patient seemed to have acquired a greater resistance to the rays and did not respond promptly. The *x*-rays, apparently, were not as efficacious as gamma rays. Radiation of the bone-marrow, also, was not followed by better results. Persistence of the spleen to renewed enlargements usually was an indication for splenectomy.

We may say that radiations in splenomyelogenic leucemias retarded the fatal outcome from two to four years.

Dr. Aikins (concluding discussion). In treating these cases with radium we have always considered the leucemia so grave that an erythema is of minor importance. However, we avoid this whenever possible. We have found it necessary to give a certain amount of radiation before any improvement can be expected in the condition of the patient. In severe cases as much as 2,000 to 4,000 mgm. hours is required. In reply to Dr. Withers' question I may say that I have not estimated the possible lymphocyte count per cubic millimeter but the highest count we have had was 750,000 per c.mm.

THE TECHNIQUE OF RADIATION THERAPY OF ESOPHAGEAL CARCINOMA*

BY JAMES T. CASE, M.D., F.A.C.S.

BATTLE CREEK, MICHIGAN

IN few situations does a malignant lesion present greater difficulties in the technique of radiation application and dosage, or less probability of completely destroying the neoplastic tissue than in carcinoma of the esophagus. Unfortunately, the attention of the patient is not drawn to his trouble until dysphagia appears; and this is therefore the earliest clinical symptom, usually the one which brings the patient to the physician. Yet esophageal carcinoma furnishes a large proportion of erroneous diagnosis or failures to diagnose, owing to the absence of the symptom of dysphagia. This was shown in the statistics published some years ago by Richard Cabot, after reviewing the incorrect diagnoses in a large series of cases at the Massachusetts General Hospital.

Roentgenologically, the earliest sign of esophageal carcinoma may be due to the obstruction of constant grade one would expect from the organic stenosis attending the malignant lesion. The writer has found many cases of esophageal carcinoma where the first signs of obstruction were apparent long before there existed any actual narrowing of the esophageal lumen, the hindrance being due to a spasm set up at the level of the early malignant lesion, or just above it, a considerable time before the infiltrating process had brought about actual stenosis. This is especially true of those cases of carcinoma of the lesser curvature high up in the stomach involving the cardiac orifice. It often happens that these obstructions are at first considered spastic because the administration of antispasmodics temporarily relieves the dysphagia. Occasionally an extra-esophageal malignant mass will be accompanied by a spasmodic obstruction in the esophagus. The writer has in mind particularly one case in which the esophageal obstruction was by post-mortem shown to be due to a carcinoma of the lesser curvature of the stomach, with extensive infiltration of the glands about the cardiac orifice and some infiltration of the cardia; yet the site of the obstruction in the esophagus, as determined both by sounds and by the roentgen studies, was two or three inches higher than the infiltrated area, and it had all the earmarks of a spastic hindrance. We therefore make routine use of antispasmodic medication, both in the study and the treatment of esophageal lesions thought to be malignant. One of the most important technical problems to be overcome in radium treatment of esophageal cancer is the delivery of an adequate dose of homogenous radiation into the depths of the tissues. The investigations of Friedrich, supplemented and corrected by Schmitz working in Friedrich's laboratory, show how rapidly the efficiency of radiation from a radium capsule diminishes at a short distance from the applicator; so that unless one does considerable damage through overdosage to the tissues actually in contact with the radium applicator, he will not deliver an efficient dose into the depths of the lesion, say only two centimeters beneath the mucous membrane, and certainly nothing like an efficient dosage along the normal lines of extension. If the lumen of the stricture suffered sufficient dilation to permit from 8 to 15 mm. of rubber tissue wrapped around the radium in its usual metal container, the added distance from radiant source to mucosa would greatly improve the depth dosage, though much prolonging the time of application. Yet, one hesitates to dilate a malignant stricture at all, and in the light of our present knowledge he surely will not do so any more than is absolutely required for introducing some form of radium applicator, fearing that the instrumentation may do more harm than the radiation does good. The radiologist is thus by circumstances limited to an unequally distributed, non-homogeneous radiation, if he depends upon radium alone; therefore the natural tendency to supplement the radium application by external applications of radium by packs applied at some distance from the skin, or by deep roentgen irradiation, or by both.

---

*Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

Another serious problem is an accurate visualization of the lesion, as interpreted from the *x*-ray and clinical findings. Some have recommended the routine study of these patients by means of the esophagoscope, but such instrumentation is extremely distressing to some patients and, for various reasons, quite impossible in others.

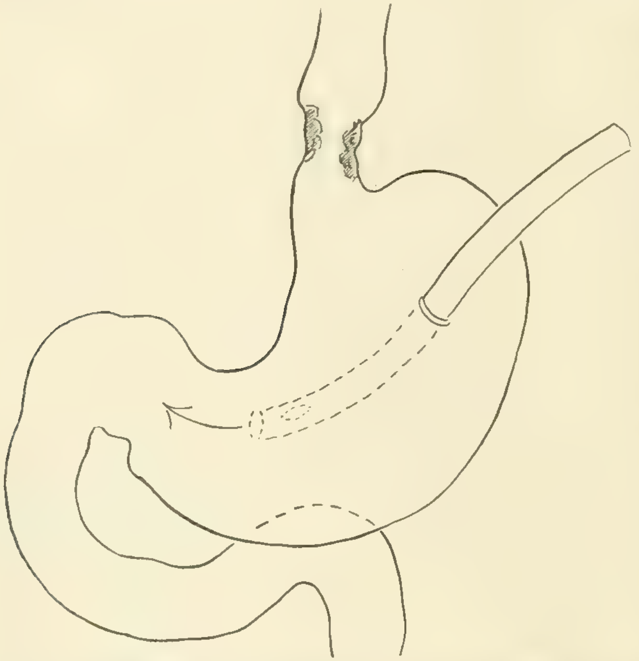


Fig. 1. Gastrostomy tube introduced into the stomach in such direction that a duodenal sound passed through this tube will be directed into the pylorus.

It is not easy to make an accurate map of the infiltration or ulceration in any given case, and yet an error of estimation amounting to only a centimeter or so makes a great difference in the result. The above considerations emphasize the obvious need of the greatest possible accuracy in the mental picture formed of the lesion under attack, the need of abundant filtration and a maximum of distance from radiant source to lesion, none of which ideals are capable of satisfactory realization, at least in the present state of our attainments.

RADIUM METHODS

Various methods have been devised and employed by all of us in the attempt accurately and efficiently to place the radium.

1. *Radium-bearing Sound Guided by a Thread.* By the well-known technique, a thread several feet in length is employed. Eight or ten inches of this stout but very fine thread is enclosed in an ordinary 5-gr. capsule and swallowed. Careful "feeding" of the thread aided by hypodermic injection of atropine to the point of securing marked dryness in the throat, plus the frequent sipping of small amounts of warm water, will, in most cases, carry the thread through the stricture and on along the digestive tube distally until traction on the thread reveals the stout resistance offered to attempts at withdrawal.

In other cases success has followed the use of atropine to the point of marked dryness of the mouth followed by a little paraffin oil. The thread once in place, it is a relatively simple matter to give the patient a swallow of a barium mixture, not too opaque, to permit accurate screen observations of the site of the lesion, and to thread over the silken guide the radium-bearing sound, the construction of which will be taken up further on. When through with the silk thread, it is withdrawn by mouth as far as possible and cut off, the remainder passing on into the intestine. Not the least difficult of the steps of this procedure is the *maintenance* of the radium in proper position, once it has been placed under the guidance of the fluoroscope. The writer prefers to put a mattress and other comforts on a horizontal fluoroscope and leave the patient lying quietly in the position assumed during the sounding. The distal end of the radiferous sound is attached to the cheek by adhesive plaster, first bending the sound over the teeth in such a way as to mark securely the proper location. It is well to alter the position of the sound, deliberately attempting to place it a little too far at the first and a little short of the lesion at the third change.

2. *The Radiferous Sound Canalizing the Stricture under Fluoroscopic Guidance.* This method, already long before devised and practiced by various radiologists, was reviewed and improved by Mills at the St. Louis meeting of this Association. Mills deserves special recognition for the very ingenious modifications of the sound, permitting the terminal radiferous end to be bent in only one of four directions, while the remainder of the sound is susceptible of any sort of angulation. This small but very important addition to the instrument permits canalization under screen control of practically every organic stricture to be met; yet occasionally one sees a case in which the method is impracticable. Sometimes the stricture is too tight for passage; again sometimes the patient proves to be unable to tolerate the esophageal and pharyngeal manipulations; the instrumentation of the lesion, with more or less traumatism, as in the thread method, is prejudicial to success; and finally many patients experience the greatest distress in maintaining the sound so long in the esophagus because of the hurt to the pharynx and mouth.

3. *Gastrostomy, Plus Thread Method.* A gastrostomy may be performed, under local infiltration anesthesia, the technique being such that an efficient valve-like gastrostomy opening results. It is the writer's custom to perform this operation in such a way that the gastrostomy tube points toward the pylorus, care being taken to use a rather large tube, sufficient to permit the passage through it of an ordinary duodenal tube without its metal tip. Almost immediately after the operation, if not at once, a duodenal tube is passed through the gastrostomy tube, on through the pylorus well into the duodenum, the position being verified by *x*-ray observation. It is not required to move the patient to the fluoroscopic room; a bedside *x*-ray equipment is quickly moved to the patient's room, and little trouble is caused by slipping a film beneath the sick one, to make the necessary *x*-ray exposure. Duodenal feeding is begun at once. The operation successfully performed, a thread is prepared, as in the first method described, and one end of it, in a capsule, swallowed. A fine thread may be employed, a stouter one being drawn down, once the end of the finer one has been recovered from the stomach through the gastrostomy opening. Formerly the writer used an ordinary shoe-button hook or a strabismus hook, or Kellogg's ligament hook, to fish up the thread, but a simpler way recently presented itself. With an ordinary washout 3–4 oz. syringe, fill the stomach with water; then, leaving the syringe attached to the tube, withdraw the tube, syringe and all. The thread readily floats out through the opening with the escaping fluid. By gentle traction the fine thread is pulled down, drawing with it a much stouter guide thread. When the stout thread is in place, from mouth to gastrostomy opening, the lower end of the thread is passed through the gastrostomy tube, which is again introduced into the stomach. Under the traction required to pull down the radium applicator attached to the upper end of the thread, damage may be done to the lining of the stomach by the "sawing" of the thread unless this tube be in place. The inner end of the tube may even be pulled up into the

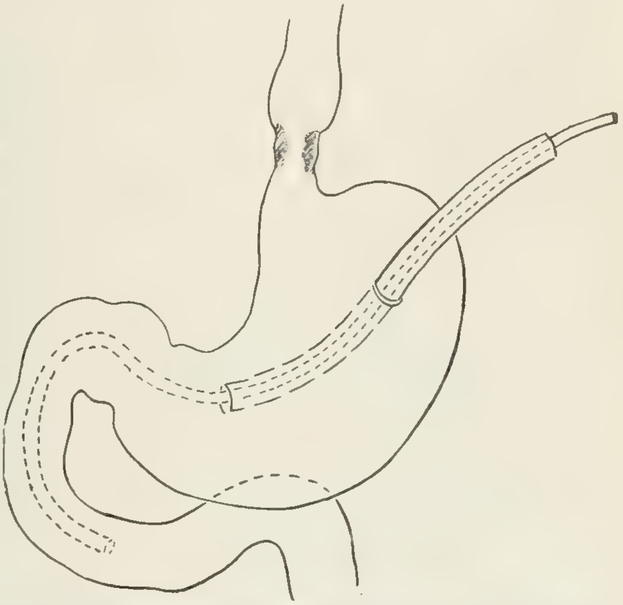


FIG. 2. Representation of the duodenal sound passed through the gastrostomy tube and on into the duodenum for duodenal feeding.

lower end of the esophagus, which is additional insurance against "sawing" the mucosa. It is important to maintain a thread attachment to the radiferous capsules through the mouth, for one may need to alter the position either upward or downward. On one occasion the extra silk thread served for removal of the capsule when the other end of the thread broke. Among the advantages of this thread method when combined with gastrostomy may be mentioned:

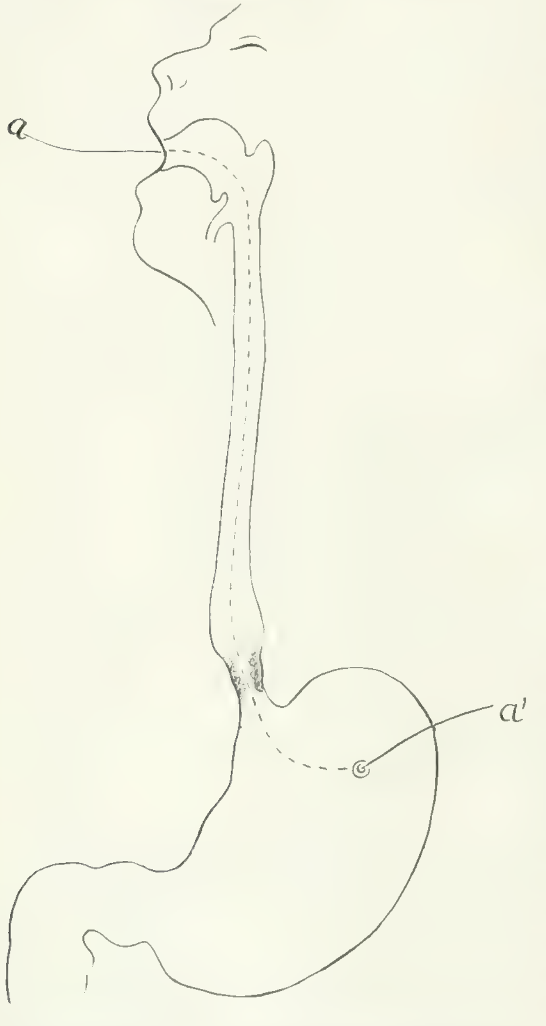


Fig. 3. Thread $a - a'$ passed from the mouth through the esophagus, past the malignant stricture, and out through the gastrostomy opening.

(*a*) The ability to begin abundant feeding at once and to maintain good nutrition through the gastrostomy opening.

(*b*) The greatly lessened discomfort to the patient during the radium treatments.

(*c*) Ability to place the radium more accurately. It is needless to add that all these manipulations and collocations of the radiferous capsule are done under careful and repeated screen control.

As to the added comfort to the patient during the application, when only a thread passes through the mouth and pharynx instead of the very uncomfortable sound, it is possible to construct a sound in such form that the staff can be removed after the placing of the capsule, which is removed later by means of a thread left attached to it. However, the writer feels that in view of the ultimate bad prognosis and the necessity of improving the patient's nutrition immediately and maintaining it, the gastrostomy is a desirable addition to the technique.

Of course, in this gastrostomy-thread method it is possible to pull up the radiferous capsule from below through the opening in the stomach; but this traumatizes the gastrostomy opening, and much distress is caused by the traction on the thread in the mouth and pharynx.

4. *Esophagoscopic Implantation of Radium Needles or "Seeds."* This is a method in which the writer has had little experience, but one which is highly recommended by several well-known men (Yankauer, Guisez, etc.). The latter recently reported several cases in which apparent cure has lasted nearly three years, where radiferous needles have been placed in and about the esophagus lesion under the direct control furnished by esophagoscopy. In the experience of the writer and his colleague there are many objections to esophagoscopy in these patients, who are weakened, old, and often in such a state of distress that esophagoscopy cannot be tolerated. Even when accomplished, the implantation of needles is thoroughly done only around the upper pole of the stricture, and there is the ever-present danger of perforation, either immediate or after a few days. One case has been reported where death occurred from a small perforation into the aorta. In the employment of this technique "seeds" of radium emanation are preferable to any other form of radium applicator.

This method has the obviously great advantage of permitting accurate vision of the lesion and the progress of the treatment. Undoubtedly the method will appeal to the men who have had special training in esophagoscopy.

PURELY ROENTGEN METHOD

Under modern roentgenotherapeutic voltage, long focus-skin distance, large fields and heavy filtration, the administration of a highly efficient dosage of roentgen rays to the neighborhood of the esophageal lesion is feasible. The writer employs four fields, as a rule centering the radiation as nearly as possible upon the carefully mapped out objective. The dosage upon the skin is variable, the intention being to deliver to the lesion considerably more than a full erythema dose (120–130 per cent E. S. D.). Our effort has been to deliver this dose within about four days' time; but the observations of Regaud and his colleagues give good ground for the belief that the same dose given in from ten to twelve days' time is more efficient, while being much less distressing to the already weakened, undernourished patient. Surely the roentgen method has the advantage of avoiding all intraesophageal manipulation. This, according to Simone Labord, is a reason for preferring the roentgen method to the exclusion of intraesophageal radium, for fear that radium treatment of esophageal cancer sometimes actually shortens the patient's existence.

COMBINATION ROENTGEN AND RADIUM METHOD

A combination of the external application of roentgen radiation with the intraesophageal application of radium appears to the writer to be the ideal method. This belief is borne out by our clinical results which show greatest prolongation of life, although our results are no better than those reported by Mills a year ago. We have performed gastrostomy on three-quarters of our patients, and have given them by this means alone a marked degree of palliation.

COMMENT

In our own work we prefer the method of gastrostomy under local anesthetic, followed in ten days by the placing of the thread, and three or four days later by the first application of radium. A series of roentgen applications through four fields is then given, if it has not already preceded the operation. On about the twentieth and twenty-fifth days further radium is applied, and a program of watchful waiting instituted. In the preparation of the radium applicator, whether for use by the sound or by the thread and gastrostomy method, it is our custom to use two, and at times three, capsules, placed end to end, a 100 mgm. in the middle, and a 50 mgm.

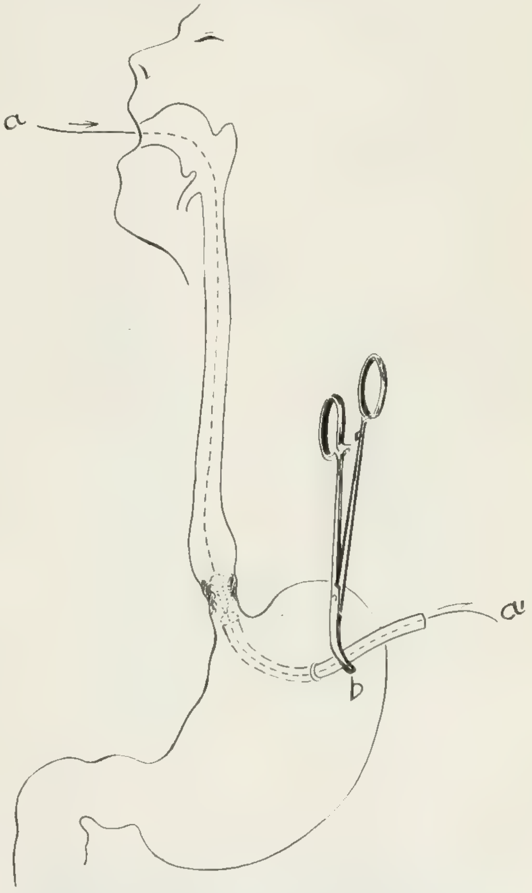


Fig. 4. This thread is then passed through the gastrostomy tube, which is reintroduced into the opening into the stomach. Traction upon the thread *a* — *a'* in the direction of *a'* pulls the inner end of the gastrostomy tube up to the inferior border of the stricture thus preventing sawing of the thread upon the soft tissues at the cardia. The radiferous capsule is then drawn down the esophagus into the stricture under *x*-ray guidance and the taut thread held in position by the forceps "b" clamped on the gastrostomy tube close to the skin.

capsule on either end. The whole is contained in the usual 1 mm. of brass filter and wrapped with plastic rubber of the thickness estimated feasible in the given case, using the maximum amount of wrapping. Near the upper end of the preparation, a cuff of rubber is wrapped in such a way as to form a guard against the slipping of the preparation entirely below the stricture. Of course, in some cases it is impossible to canalize the narrowed lumen with even the ordinary applicator in its brass cover, to say nothing of additional rubber; in such cases we content ourselves with the silver filter for the first time, usually finding that it is possible, after the lapse of a few days, to use the more bulky applicator.

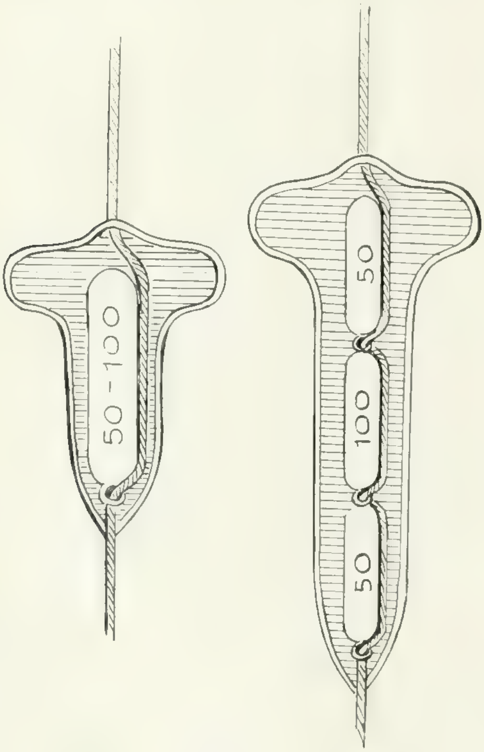


FIG. 5. Details of construction of radiferous capsule. The radium capsule threaded is wrapped with elastic rubber in such thickness and shape as the indications of the case permit. The upper end of the capsule is widened out so as to form a shoulder. One can feel impaction of this shoulder against the upper end of the stricture and thus know when to stop pulling.

Renewed roentgen applications and radium treatments are given when circumstances warrant, but it is our intention and hope to give all the radiation necessary during the first attack. We hope so to perfect our calculations and our technique that this may be realized; but to date we have found it necessary to continue treatment into the second or third series.

The method preferred by the writer includes, then, the following:

1. Careful *x*-ray survey of the lesion, realizing how much of the deformity in the esophageal lumen may be due to associated spasticity.
2. Preliminary deep roentgen treatment.
3. Gastrostomy, followed at once by duodenal feeding.
4. Ten to fourteen days later placing of thread from mouth, through stricture, and out of gastrostomy opening.
5. Intraesophageal radium treatment by aid of this thread under careful fluoroscopic screen control, endeavoring to administer all necessary radiation during first attack.
6. Careful periodical review of case from month to month with repetition of radiation therapy as needed.

DISCUSSION

DR. HENRY SCHMITZ, Chicago, Ill. The treatment of cancer of the esophagus has been anything but encouraging in the hands of most of us. The reasons for this are: First, the trauma which is usually caused by the insertion of the radium dose, and second, the impossibility of applying the correct radium dose. I feel that we can congratulate Dr. Case upon the method he has demonstrated. It appeals to me as the most rational of which I have heard. The danger in the use of radium in the esophagus is the local destruction caused by the radium. The trauma results in increased difficulty in swallowing, interferes with nutrition and decreases the strength of the patient alarmingly. I have not seen any case in which we have had even temporarily good results. The patients have been worse off after the application of radium than before.

The method advised by Dr. Case insures proper feeding and enables one to place the radium capsule correctly and for a length of time necessary to insure results. Finally, the added radiation of the *x*-ray enhances the efficacy of the treatment.

DR. SANFORD WITHERS, Denver, Colo. I am heartily in accord with the use of a gastrostomy to relieve the continual massage of the esophagus by the passage of each bolus of food.

For placing the radium in such cases I mold a sort of shoulder-like disc of wax on the capsule or wire guide to prevent the radium from going below the stricture. The radium capsule and hard wax disc are covered with paraffin to give a smooth nonconductive coat.

Dr. H. H. Bowing, Rochester, Minn. I do not know whether our results are any better than those of Dr. Case, but certainly they are better than those of Dr. Schmitz. These patients get a wonderful amount of relief from the dilatation alone. I recall one patient who returned to his work and lived for three years. His only symptom, when last seen, was a chronic cough, and the *x*-ray examination of the chest showed multiple metastatic areas. If we had given him irradiation we would have credited this improvement to the treatment. We can probably give the majority a longer lease on life with treatment than without it.

We use the string method described by Dr. Case. With the string in position the sound may be passed along its course with the least chance of injury to the diseased esophagus. We always begin with a small olive, and increase the size until we get one that enters with some difficulty; then we know we have an olive that will help to hold the radium applicator in position. The applicator itself is about 7.5 cm. long and it will hold two tubes of radium.

The upper end of the applicator is fitted with a large olive that will not go beyond the obstruction. The smaller olive will just go through the tumor and will not be regurgitated; the large olive is fitted with a whalebone bougie. The latter has previously been marked in order that the depth of the lesion from the incisor teeth is known. When the applicator is in position we can withdraw the whalebone bougie and to this we have attached several strands of strong fish line. We are absolutely sure the patient will not swallow the applicator and that it can be withdrawn. The patient can tolerate the applicator without any signs of difficulty, but I have found that there is a great amount of trouble with excessive salivary secretion; this is distressing and can be controlled with morphin and atropin.

We are not satisfied with our results, but I know we can apply the radium in the esophagus with some assurance that it will stay put, and the patient can wear the applicator for twelve hours or longer without much discomfort.

Dr. W. H. B. Aikins, Toronto, Ont. The appliance described in detail by Dr. Case may, I trust, result in greatly modifying the hitherto unfavorable results so far obtained in the treatment of carcinoma of the esophagus; and we look forward to hearing from him to that effect.

Prof. Lars Edling, Lund, Sweden. I have treated a small number of cases of carcinoma of the esophagus, I think not more than 10. In those I had a good result in 3 cases; in 2 I have observed a very good result; 2 cases I have observed after about two years in each case. One case was treated four years ago and that patient lived for at least two years afterward. I have heard that she has since died, but I do not know just how. The other case was treated three years ago and I saw that patient last March, when she was quite well. The third patient was treated early this year and is still alive, feeling well and can eat. The tumor was in the upper third of the esophagus and that, of course, makes the treatment very much easier, especially in regard to combining the *x*-ray treatment which has been used in all cases.

I have used for the purpose of applying the radium a common sound made of two catheters placed together so as to have the length required. I have a joint in the upper end so that the radium tube may be placed within the capsule. The radium tube is of lead with 1 mm. of gold. The capsule is placed under control of the *x*-ray and attached to the side of the face by a stitch and at the border of the teeth also by a stitch. There has been no special difficulty in holding the radium in place in these cases, but of course the patient is much distressed by the saliva. Because of that I have always used atropin, with very good results. The dosage used has been 45 mgm. and the time of treatment over twenty hours. In one or two instances the patient could not hold it, and then I repeated the dosage.

Dr. Henry J. Ullmann, Santa Barbara, Calif. I would like to take advantage of this opportunity to show a way of improvising when one has not the apparatus Dr. Bowing spoke of. A patient was presented who had refused gastrostomy. The size of the olive tip that would go the length of the stricture had been determined by means of the *x*-ray. The next larger olive was put on the rod and the lower end of a catheter containing the radium capsule was slipped over it. The thread was run through the tip of the catheter and the outfit inserted as far as it would go. The olive stopped at the stricture and the catheter end with the radium then lay within the stricture, held by the olive above. This might be found useful if a more efficient type of apparatus was not available.

Dr. Henry P. Beirne, Quincy, Ill. If you get the linen thread the harness makers use you can hold a mule with it. You can wax it down to any size you wish and never lose your radium.

As a temporary dilator I have had patients swallow an ordinary shoe button, taking it with the food and letting it make its own dilation. Two or three days later it can be pulled out and no harm done. This is a home-made affair, of course, but in one case the patient was able to eat more food and the clinical results were better.

Dr. Case (closing discussion). The gastrostomy, I realize, is objectionable; but under local anesthesia there should be no fear as regards life, and I think it is a valuable procedure. The patient's nourishment is then assured. We have a means of feeding him that is available in spite of anything which may happen to the esophagus. The point one speaker brought out about diverting the food from the traumatized area is very important.

In employing radium, it is highly necessary to take account of the amount of rubber tissue filtration placed outside the brass capsule. We know that the intensity of radiation diminishes inversely as the square of the distance of the radium from the tissue, and therefore it is necessary to use as much rubber as possible outside the metal applicator. Every additional millimeter of rubber means additional distance and adds that much more chance of not traumatizing the other parts and of getting more uniformly distributed homogeneous dose of the radium itself.

I should have added that the gastrostomy tube should be left in place while traction is being made on the lower end of the thread to pull the radium down the esophagus to the proper site above and in the stricture; and with a forceps clamped upon it, the thread may be held in place. When we cannot use additional rubber on account of the small size of the lumen of the stricture, we use the smallest applicator and leave it in only a couple of hours. In a few days we can put in a larger applicator. We should not assume the full dose given until we can put in an applicator with at least a half centimeter of rubber around it.

If the patient refuses a gastrostomy, I then prefer the method brought out by Dr. Mills last year. In that way I have been able to canalize strictures which would not permit the passage of even the smallest olive. I hesitate very much to attempt to pass an olive in these cases, for the reason that we sometimes, under the fluorescent screen, see the wall of the esophagus above the stricture balloon out in a dangerous manner. The slightest additional pressure would surely make a perforation. Under the screen guidance, however, we are able to avoid this danger.

In most cases an adequate dosage will not be administered with the use of a single applicator. I have been using three, with a 100 mgm. applicator in the middle and one of 50 mgm. above and a similar one below.

RADIUM THERAPY OF VASCULAR NEVI*

BY HOWARD MORROW, M.D., AND LAURENCE R. TAUSSIG, M.D.

SAN FRANCISCO, CALIFORNIA

ONE of the most striking actions of radium on living tissue is that of producing an obstructive endarteritis in the smaller blood-vessels. This is one of the most useful properties of the rays in the treatment of neoplasms, probably extending the effectual zone considerably beyond the actual destructive zone by cutting off at least part of the nutrition of the growth. This more or less selective action on the blood-vessels was early recognized, and vascular nevi were among the earliest benign lesions treated with radium. Several investigators treated occasional vascular nevi with radium, but Wickham and Degrais were the first to systematize work along this line and to publish the results of a considerable number of cases. Some of the illustrations in their "Radium Therapy" show end-results which their successors may well envy. This was in spite of the somewhat hazy notions then held of the physics of radium. We are able to procure applicators containing a definite amount of radium element per unit of surface. Accurate investigations have been made on the effect of various screens, on the influence on the dosage of variations in the size of the applicator and its distance from the lesion to be radiated. This type of research is of great importance in taking radium therapy out of the field of empiricism and placing it on a sound scientific foundation which is essential to progress.

In the treatment of birthmarks, certain general considerations must be borne in mind. The work is done, as a rule, solely for the cosmetic result. Therefore it is preferable to remove a mark incompletely or not at all rather than to substitute for it a prominent, ugly scar.

Parents and relatives have frequently been led to expect that the nevus will be removed completely, leaving normal skin. It is true that in some of the best results the scar is scarcely noticeable, but there is always some atrophy, and even though the utmost care and skill has been used, telangiectases may occur. It seems that the skin over a vascular nevus develops telangiectasia more readily than other skin. These telangiectases can usually be removed satisfactorily by the water-cooled mercury lamp (Kromayer type) or by electrolysis or by the application of an acid. Experience has shown that the beta rays are more efficient in the treatment of vascular birthmarks than the gamma rays. They should be used whenever it is possible, but their usefulness is limited by their relative lack of penetration; and therefore, when the involvement is quite deep we must often use only the harder beta rays, and even exclusively gamma-ray radiation. In general it will be found that birthmarks of the vascular type are more amenable to radium therapy in young children than in adults, when bright red rather than when blue red, when smooth rather than when verrucous, and when the color can be readily and evenly obliterated by pressure.

There are numerous classifications of vascular nevi, none of which is entirely satisfactory. That which McKee adopted in "*X*-rays and Radium in the Treatment of the Skin" is a satisfactory working terminology. The true vascular nevi are divided into: nevus flammeus or port-wine mark, nevus vasculosus or strawberry mark and angioma cavernosum. These will be taken up separately as each requires a different technique and yields different results, though the essential pathology is similar. Spider nevi are not true nevi and should not be treated with radium.

Nevus flammeus is flat and varies in color from an almost indistinguishable pink to a deep purple red. It varies in size from that of a pinhead to that of a lesion which covers half of the head or more. The distinguishing feature is that it is not raised above the level of the surrounding skin. The color is usually homogeneous but it may be blotchy or there may be more or less numerous telangiectases. Occasionally angiomatous nodules are present or may develop in a port-wine mark. A few capable radium therapists, notably Simpson in this country, report splendid success in treating this type of lesion, while most of the others advise against attempting to treat them with radium. All agree that a good result can be obtained in only a limited number of them, by the combination of considerable care and experience. We have never attempted to eradicate entirely one of these nevi, but we have in a very few instances attempted to pale out the lesion somewhat. The result has never been entirely satisfactory. Radium plaques or toiles are the only applicators suitable for this work. The weaker plaques, one-half or one-quarter strength, are preferable to the stronger ones. Toiles of about one-twentieth strength are useful but do not stand ordinary wear very well. Tubular applicators are not advisable. A very thin screen or no screen at all should be used. A quarter-strength, glaza plaque, screened with 0.1 mm. of aluminum or just covered with a layer of rubber dam, may be used for five to fifteen minutes on each area every three or four weeks. If a slight erythema is produced the dose should be cut materially the next time and the interval between treatments increased. The ideal dose is that which is just short of erythema. With this type of radiation, a moderately severe reaction will heal promptly without serious scar, but the probability of telangiectases and atrophy make it unsafe to cause more than the slightest erythema. Gamma and roentgen rays have practically no effect on these nevi. In most instances ultraviolet light treatment with the water-cooled mercury lamp is better, and radium therapy should be attempted only in small lesions in which the color is quite dark and evenly distributed.

---

*Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

Nevus vasculosus is raised above the nivus of the skin. This elevation varies from a scarcely perceptible swelling to two or three millimeters or more. The surface may be smooth or quite verrucous. The color varies from a pink red to a deep violet or bluish red. These appear most frequently on the face but may appear on any portion of the body, and they vary in size from that of a pinhead to that of a palm or larger. They are frequently about the size of a dime. Strawberry marks are present or appear shortly after birth and may grow for a time, but usually reach their maximum size early. Very rarely one of these marks undergoes spontaneous involution. When they are not complicated by a cavernous element, they are ideal subjects for radium therapy. A small superficial smooth lesion can frequently be cured by a single application. The dose used will depend very much on the type of lesion. One that is slightly raised, evenly colored and smooth should be given from twenty to forty minutes' exposure with a half- to quarter-strength plaque screened with 0.1 mm. of aluminum; while thicker lesions should receive from one to one and a half hours with a similar plaque screened with 0.3 mm. of brass or the equivalent. If there is any reaction from the first treatment, a second should not be given until it has faded entirely. If there is no reaction, practically the same exposure should be given in about three or four weeks. A lead-foil diaphragm must be used to protect the contiguous normal skin unless the applicator fits the lesion closely. Following an erythema there is usually an increase in the pigment around the area treated. This often persists for several months, but eventually fades entirely. If the first two or three treatments do not effect a satisfactory result, subsequent treatments should be spread over a considerable period of time. Should telangiectases occur, they are treated with ultraviolet light, the electric needle, or acid.

Cavernous angiomata may occur on any portion of the body. Their size varies from less than that of a finger-tip to that of a baseball. They are usually circumscribed, more or less spherical tumors, but they are occasionally quite diffuse. They are frequently entirely subcutaneous, without involvement of the epidermis, in which case they may be entirely colorless, though they usually present a faint blue or violet color. Angioma cavernosum is very often surmounted by a strawberry mark which may only partly cover the cavernous lesion or may be coextensive with it. These are more or less compressible, though they may seem to be fluctuant. Occasionally one is seen with a pedicle, in which case it may be readily excised; but usually they present considerable resistance to surgical treatment. The technique of the radium treatment of these lesions is simple. Usually plaques of half or quarter strength are used and may be screened with 0.3 mm. of brass and an exposure of one to two hours given every four to six weeks over each area. If the lesion is large the principle of cross-fire can often be used to advantage. Most of these will require from nine months to two years for a satisfactory result. Tubular applicators may be used satisfactorily with a little care. A tube screened with 0.5 mm. of silver, held ½ cm. from the surface may be left in position to give 25 mgm hrs. to each sq. cm. of surface, using balsa wood, gauze, or some other light material to obtain the distance. Another form of therapy that has been used is intratumoral radiation, either from steel needles containing radium element, or from unscreened tubes of emanation. The steel needles, of 10 or 12 mgm., should be inserted 2 or 3 cm. apart and allowed to remain in place for not more than six hours. If bare tubes are available, they should be inserted into the base of the lesion and should contain 0.1 to 0.2 mc. of emanation each. The intratumoral radiation of cavernous angiomas has seemed rather radical to us and we have been loath to try it, although those who are using it are enthusiastic. This form of radiation may be combined with the ordinary surface radiation.

CONCLUSIONS

1. Our experience in treating vascular nevi with radium has shown that the results are better than with carbon dioxide snow or any other therapeutic agent.
2. Radium therapy is most satisfactory in treating nevus vasculosus, next in treating cavernous angioma and least satisfactory for nevus flammeus.
3. Beta rays should be utilized as much as possible.
4. Severe reactions are not justifiable.

DISCUSSION

Dr. Sanford Withers, Denver, Colo. I think the paper very well sums up the consensus of opinion regarding the treatment of this type of angioma. We quite agree with Dr. Taussig that the port-wine marks are the hardest to treat, but it is almost impossible not to get good results in treating the strawberry marks with infrequent, short exposures to radium plaques.

We have been getting away from radium in the treatment of port-wine stains. It may be of interest to describe what we are using. It is the mercury vapor arc lamp of the water-cooled variety; and, not content with one blister, as soon as the first one can be peeled off we blister again in a period of from one to two weeks and then wait a month to note the effect. It is remarkable to see how quickly these port-wine stains that are irregularly distributed will disappear. We have occasionally given five or six blisters in a period of six weeks, but that is unusual. This treatment produces a pigmented zone that exists around the area for months but gradually fades away; and the appearance of the treated area blends into the normal skin and leaves an area not nearly as marked as the postage-stamp reaction from a radium plaque.

I wish to lend my emphasis to the fact that beta radiation is the thing to use in these cases. It has been used ever since Wickham and Degrais brought out the toile of low activity. This has tempted me into the use of beta radiation for the large cavernous angiomata. In order to eliminate skin reactions as much as possible, I have been using imbedded tubes of low activity, from 0.2 to 0.3 mc. each. An attempt is made to produce a complete retrogression of the lesion at one sitting. This method gets the crying youngster out of the office quickly and eliminates the possibility of the applicator becoming displaced during treatment.

I think there is a definite place for the compression bandage during the radium application and particularly with the use of the bare tubes or needles. I believe we increase the action. I like to make the compression firm, and press out as much of the blood of the cavernous nevus as possible.

I heartily agree that we are never justified in producing more than an erythema for the ordinary superficial variety of nevus. I think most men are likely to push their treatment too far.

I would like to know what experience these gentlemen have had in the treatment of lymphangiomas and whether there should be any difference in the method used.

Dr. H. N. Cole, Cleveland, Ohio. I like this paper very much, and the thing I liked particularly was the conservatism. If anything, I want to go even further in my conservatism than the authors have. I think a reaction to radium in angiomata is never justifiable. In an angioma we have something that the public will look upon for the rest of the patient's life, and it is not necessary for it to clear up in a few weeks. It is better to take several years if necessary to get a better result. Two things are necessary in the treatment of these cases, one radium and the other time, and I lay more emphasis on time than on radium. We use radium too often in angiomas and I have learned by bitter experience in some of my first cases that it is much better to go slowly and to put lots of accent on the "slowly." Treat them once in two or three months, as Dr. Withers said, and use light doses. The results are better than even if you use a light exposure and use it frequently. In one type, the port-wine stain, we can get better results with the quartz lamp. We give an exposure of not more than five or ten minutes using a half-strength plaque and screen of 0.2 mm. aluminum and tell the patient to come back in two or three months. Do not be in any hurry to use another application. This holds true in the strawberry nevus as well. It is not necessary to cure them in six months, and it is much better to wait for a year. I have had too many cases come in a year or two after treatment with telangiectasia and tell-tale postage-stamp mark that will be carried all through life; and I am convinced that it is far better to go slowly and avoid the danger of these results.

In the treatment of cavernous angiomata I think again we should go slowly. Allow plenty of time between the exposures. I think the compression bandage is a good thing. By the compression you will expose the cells to more radium than you could otherwise and get a much better result. Do not give enough radium therapy to cause any effect on the skin.

I do not think there is much difference between the treatment for lymphangiomata and for angiomata. You get very good results on either the skin or the mucous membrane. I have had several cases of lymphangioma of the tongue and have had satisfactory results with surface applications and cross-fire.

Dr. R. H. Stevens, Detroit, Mich. I am heartily in accord with most of what has been said regarding the treatment of nevi with radium. I began treating with the Finsen light some twenty years ago and we got some very good results. Since then I have used the quartz light with satisfactory results and have also had good results with radium therapy, particularly in the small lesions, when it is used in quite young children.

I wish to emphasize Dr. Cole's remarks about time. Delay the treatments, giving long periods between them. I have treated nevi and have not repeated the treatment for six months or a year. If you watch carefully you will see the nevus disappear gradually over a period of a year or eighteen months. In the case of a little girl who was treated with a small amount of radium for a cavernous nevus' on the end of her nose, I treated it when she was two or three months old, and when I saw her recently there was no atrophy of the skin, and one could not tell that there had been anything wrong with it. The result was perfect. I agree that most of these cases are treated too frequently and I advise not repeating the treatment within three, four or six months, or possibly a year.

I recently had some experience with an aneurysm around the mouth, with large vessels through the skin and mucous membrane of the cheek. We used heavy doses of radium, well filtered, and got rid of most of the vessels so that I could turn the patient over to the surgeon for the eradication of the large vessel. Before treatment it was really a serious condition with the mucous membrane pressed in against the teeth. The improvement was marked.

Dr. R. E. Loucks, Detroit, Mich. I am very glad to hear of the conservatism that is shown in the treatment of these lesions. I described a method of treatment with a flat applicator several years ago. The child is brought to the office and given a feeding so as to produce sleep. The skin over the lesion and the rubber dam covering the applicator are sprinkled with talcum powder to prevent adhesion, and the applicator is ironed over the area with sufficient pressure to flatten out the superficial blood-vessels. In this way you avoid the outline of the applicator, and are not so likely to have telangiectasia. The reaction from each treatment should be noted, for no two treatments in different individuals are alike. The blond child may have an erythema in ten or twelve minutes, while the brunette may require fifteen or eighteen minutes.

In the treatment of lymphangiomata, we had one case of the tongue where the condition was classified as macroglossia. The child's tongue protruded through the lips, and it could only eat by sucking. It could not close its teeth, as the development of the jaw was so interfered with by the tongue that there was an opening of an inch between the anterior teeth. The child could not go to school because of this deformity. We obtained excellent results, and within eight or ten months the tongue was reduced in size, so that it could be kept inside of the teeth, and by means of a dental splint the jaw was changed so that the teeth articulated. I am convinced that slow treatment in all these conditions is the better plan.

Dr. Morrow. We have had no experience with lymphangiomata, all our work having been done with the angiomata.

Dr. Taussig (closing discussion). I think the ground has been very well covered and am glad that everybody agrees on conservatism, and that some go even further than we do in this regard.

One thing that we have found useful, is the application of a few drops of flexible collodion on the surface of the plaque, attaching it to the angioma or strawberry mark. Of course, that is just the opposite of the plan spoken of by Dr. Loucks, but I think if the surrounding tissue is screened with lead foil one is sure to get the action in exactly the place desired instead of half an inch below.

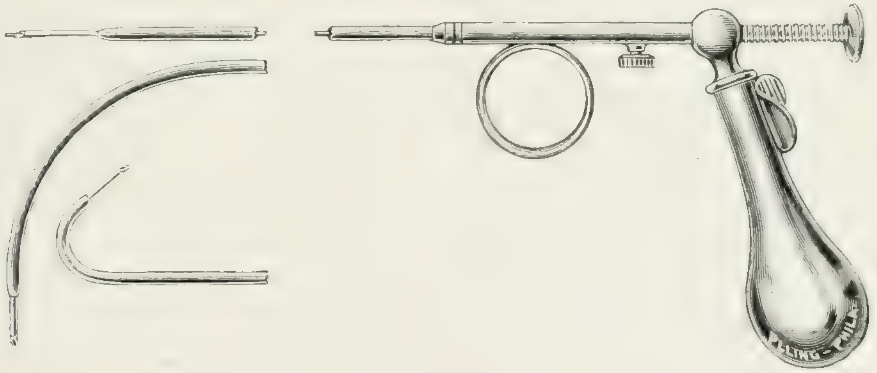
AN INSTRUMENT FOR THE IMPLANTATION OF BARE RADIUM EMANATION TUBES INTO THE TISSUES

BY WILLIAM NEILL, JR., M.D.

Associate Surgeon, Howard A. Kelly Hospital

BALTIMORE, MARYLAND

NUMEROUS instruments have been devised for permanent implantation of bare glass radium emanation tubes into the tissues. In 1920 Dr. Robert M. Lewis (at that time an associate at this hospital) had made an instrument for implanting these tubes into the female bladder through the Kelly aero-cystoscope. This instrument was similar in principle to the ones shown here, but owing to mechanical difficulties, it did not prove practical. A short time afterwards, I had three types of instruments made for this purpose by the George P. Pilling and Son Company of Philadelphia, Pa., which have been entirely satisfactory.



A steel cannula with a needle point 2 cm. long and 2 mm. in diameter is attached to a large handle placed at an angle which affords a good grip and a finger catch for counter pressure against the thumb push. The radium tubes are ejected from the needle into the tissues by means of a stylet running the entire length of the instrument.

The first type is applicable for all oral, intravesical, vaginal and rectal cases. The second is so curved that all intralaryngeal growths can be accurately implanted. The third is curved at the end and can be used with accuracy in a number of cases for implanting tumors of the nasopharynx.

At the time of treatment it is preferable to have the desired number of instruments previously prepared to facilitate the implantation in order that it will not be necessary to rethread the same instrument a number of times.

It is important that the point of each instrument be dipped into sterile boric ointment or vaseline immediately after the emanation tube has been threaded into it. This acts as a good adhesive plug and prevents the dislodgment of the tube prior to its implantation. While not in use, the instruments are kept immersed in kerosene, which not only lubricates, but prevents rusting of the stylet.

THE TREATMENT OF BENIGN HEMORRHAGE OF THE FEMALE GENITOURINARY TRACT BY RADIATION*

BY HENRY SCHMITZ, M.D., AND HARRY E. BUNDY, M.D.

CHICAGO, ILLINOIS

THE value of radium and the *x*-ray in the treatment of benign hemorrhage of the female genitourinary tract has led to the universal employment of these agents by radiologists and many surgeons. While this method of treatment has given negative results in the hands of those unfamiliar with its limitations, statistics are giving us more confidence that the results obtained are valuable.

Benign hemorrhages of the uterus amenable to radiation treatment fall into the following groups: (1) Essential menorrhagia or hemorrhagic metropathies; (2) myomata uteri; (3) inflammatory adnexal disease; (4) pernicious bleeding during gestation.

In the treatment of these conditions it is imperative to rule out malignant disease. To accomplish this it is necessary to do a careful diagnostic curettage of the endometrium, and, if necessary, excise a piece of the cervix if this shows evidence of abnormal change. It is important also to exclude disturbances due to the endocrine system, as menorrhagia is frequently found in thyroid and pituitary disorders. All tissues removed should be given very careful microscopical examination.

In treating the hemorrhagic metropathies we use a 50-mgm. capsule of radium element. The dosage varies with the age of the patient. In adolescent women and in those desiring offspring we give small doses, 300 mg. el. hrs. being sufficient. Should this dose be insufficient to bring about a normal menstrual flow we repeat the application after an interval of six months. This dose corresponds to an inflammatory ovarian dose, with the *x*-ray corresponding to a 25 per cent E. S. D. applied to the ovaries. The ovaries are 6 to 7 cm. beneath a plane drawn through the anterior superior spinous process of the innominate bones. Hence, using a 140 kv. maximum current, a filter of 0.5 mm. copper and a focal skin distance of 50 cm. and 5 ma., the time duration would be one hour through the anterior field.

In older women from thirty-five years on, the gamma-ray dosage must be 600 to 1,200 mg. el. hrs. to cause a destruction of the endometrium. The dosage of *x*-ray to cause cessation of ovulation and destruction of the primordial follicles is 50 per cent E. S. D.

Women who have passed the menopause we treat as though carcinoma were present, even though there is no microscopic evidence of malignancy. Both radium and *x*-rays are used. We have had two such patients return with a recurrence of the uterine hemorrhage and positive evidence of malignancy; and therefore we insist that the combined treatment be given in each case.

In our series of 116 hemorrhagic metropathies there have been 9 cases treated twice and 4 cases treated three times. There has been one fatality, occurring three days after treatment from septic peritonitis.

As regards the myomata the only symptom requiring radiation treatment is hemorrhage—usually menorrhagia. Myomata causing pressure symptoms, undergoing degeneration, complicated by adnexal disease or submucous fibroids, or those located in the cervix should not be treated. Myomata larger than a four month's pregnancy should not be subjected to radiation treatment unless constitutional contraindications to hysterectomy are present. Women of the child-bearing age should be myomectomized.

In our series of 54 cases of myomata 2 patients were found to have sarcomatous degeneration within six months after treatment and a hysterectomy was performed. One patient was operated upon for a submucous fibroid. In all the other cases amenorrhea or oligomenorrhea was attained.

The object of ray treatment is arrest of the menorrhagia. In one-third of the cases, the myoma will decrease in size or disappear entirely simultaneously with the process of senile atrophy. It is impossible to bring about a decrease in the size of the myoma in all cases.

---

* Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

Small fibroids up to the size of a grapefruit may be treated with radium alone; those larger than this should have *x*-rays or a combination of the two. Adenomyomata should be removed surgically if possible—otherwise treated as though malignant.

In treating benign hemorrhages of the uterus the radium capsule must be placed against the fundus. If placed accidentally near the internal os, destruction of the mucous membrane lining the internal os may occur, the result being atresia with a subsequent pyometra, hydrometra or hematometra, necessitating a hysterectomy for relief.

The menorrhagias or metrorrhagias accompanying adnexal disease and the pernicious bleeding from different parts of the body during the pregnant state are often intractable to the usual forms of treatment. Though the adnexal disease may be clinically or surgically healed, uterine hemorrhages may persist even after repeated curettages.

These hemorrhages respond almost immediately to an exposure of the spleen to a stimulating dose of rays of about 15 per cent E. S. D. We cannot explain the mode of action, as it contradicts the teachings of physiology that stimulation of the spleen reduces the coagulability of the blood. Should the bleeding persist after twenty-four hours, twice the dose is given.

We have treated 14 cases of adnexal disease, 4 febrile abortions, 2 resulting from uterine myomata and 2 gestation hemorrhages. In 19 cases cessation of the bleeding took place within twenty-four hours and in 3 cases an additional ⅔ E. S. D. was applied after forty-eight hours with prompt cessation of the hemorrhages.

It is stated that removal of the spleen causes hyperfunction of the ovaries; therefore increased activity of the spleen with an irritating *x*-ray dose would reduce ovarian function.

In conclusion, radium and the *x*-ray do not supplant surgery. Radiation therapy must be accepted as one of the best methods for the treatment of the hemorrhages of benign uterine and ovarian diseases. However, its limitations have been definitely recognized and should be strictly observed. Only then can we avoid the many pitfalls which the injudicious use of an otherwise valuable therapeutic agent will cause.

DISCUSSION

DR. JAMES T. CASE, Battle Creek, Mich. I was very much interested in the statistics given by the authors, particularly in the last class of patients, and in the results reported from radiation of the spleen in controlling hemorrhage. I understand that the ordinary methods of testing the coagulation time are of questionable value. Dr. Bundy's report is not based upon any test of coagulation time, but upon actual cessation of hemorrhage, which is a very practical proof. I have attempted a number of experiments for estimating any possible change in the coagulation time in connection with routine irradiation for carcinoma and fibroids. I have been unable to find any constant change. I am also aware that the literature is not at all in agreement regarding the experimental results. I would be glad if the authors would explain further their theory as to the cause of cessation of hemorrhage through the external application of radiation to the spleen.

DR. HENRY J. ULLMANN, Santa Barbara, Calif., I would like to add something in the way of experience with coagulation time. Last year, while radiating the abdomens of rabbits in order to produce gastric ulcer, we were taking blood from the ear veins to make counts. We found that there was a steady drop in the coagulation time following radiation and within a day or two of their death, from perforated gastric ulcer, it was impossible to get enough blood from their ears to make a count. At that time when exposing the rabbits I was about twenty feet away, with no protection except the ordinary glass bowl and two plaster walls between myself and the machine. A film exposed in the same room was fogged. My coagulation time fell from seven minutes to around thirty seconds. I was not able to get it under the microscope soon enough to get the coagulation time and it took nearly a week to return to normal.

A few weeks ago when giving heavy radiation for an abdominal tumor I found a definite drop of about 50 per cent and it returned to the patient's normal in about twenty hours. The same drop occurred at the second radiation. We are continuing the work on animals and may have something definite in a few months.

DR. SANFORD WITHERS, Denver, Colo. I do not believe that Dr. Schmitz wishes to leave the impression I received, that the effect of the radiation causing a cessation of menstruation is essentially on the ovary. Personally I have seen 2 cases that had the old classical operation of castration done and developed a menorrhagia that was controlled by intrauterine radiation.

Dr. H. H. Bowing, Rochester, Minn. I was interested in what Dr. Schmitz had to say about the carcinomatous change and would like to hear further elaboration on the 2 cases mentioned.

Professor Lars Edling, Lund, Sweden. I have had occasion to give radium treatment for metrorrhagia and myoma of the uterus at frequent intervals since 1910 and have treated in this way something like 200 or 250 cases of bleeding uterus, both the metrorrhagia and menorrhagia types, and I think about 50 to 60 cases of myomata. In the first class I have used, as a rule, 4 mgm. of radium with a filter of $\frac{1}{2}$ mm. of lead and some rubber. In the myomata I have used about the same dose but in some cases have used 16 mgm., with an extra filter of 1 mm. of silver. The results have, as a rule, been very good in the bleeding cases. In a small number of cases I have been obliged to repeat the irradiation, and this has been done routinely at least two months after the first exposure; generally not much more. That length of time gives an opportunity to observe the character of the patient's bleeding during two menstrual periods. In most cases the bleeding has ceased and in only a small number of cases have there been repeated attacks of hemorrhage. These have been controlled by means of repeated radiation, usually one treatment; but in 2 cases two doses were given. In the myomata the results have not been quite so good. There have been a certain number of cases of infection and I think they have all been due to submucous myomata being implanted by the irradiation of metrorrhagia. In such cases extirpation of the uterus has been necessary. In the last several years, therefore, I have used *x*-ray treatment with radium, with good results. This has been about our experience in the treatment of these disorders.

Dr. Schmitz (closing discussion). We began irradiations to the spleen for the arrest of bleeding about two years ago, prior to the time that any reports had come from Central Europe on similar investigations. The first case was a young woman who was pregnant. She had pernicious bleeding from the gums. She had received four huge transfusions of blood. The improvement lasted for a day or two and then she would bleed again. I advised the extract of the placenta to stop the bleeding, without any result. I then suggested radiation of the spleen, giving an irritating dose, i.e., about 15 per cent to the organ. Within two days she stopped bleeding and carried the child to full term. Labor was normal and the child was perfectly developed. We then began to pay close attention to similar cases.

In bleeding uteri a action of the *x*-rays is confined to the ovary, while that of the radium is confined to the endometrium. If we use radium we apply a dose that will destroy the surface of the endometrium. Without endometrium the menses will cease.

In one case a sarcoma was overlooked. The patient did not have the sudden increase in size of the tumor or the sudden and alarming bleeding that we usually find in malignancy, and we were under the impression that we were dealing with myoma of the uterus, and rayed it accordingly. Hemorrhage ceased. But soon she had an involvement of the lymph-nodes. We resorted to a hysterectomy and found a sarcomatous degeneration of the myoma. In the second case we made a wrong diagnosis. The patient had a large solid tumor in the pelvis, about the size of a fist. It appeared to be one with the uterine organ and was movable with it. She was fifty-six years old and had not ceased menstruation. We applied radium, but the tumor continued to grow, the patient developed pain and seemed to get worse. At first she refused to return to the hospital. Finally she came back and at that time we found an invasion of the anterior abdominal wall and lymph-nodes. Laparotomy revealed a large sarcoma of the ovary. The uterus was not involved. A panhysterectomy was done, followed by *x*-ray irradiation. She is at present in better health than she has been for years.

The only indication for irradiation that we recognize in benign conditions of the uterus is the presence of one symptom, namely, hemorrhage. If any other symptoms are present, such as pain or pressure, we refuse radiation treatment. If in doubt we prefer to subject a patient to hysterectomy or myomectomy.

A PRELIMINARY REPORT OF THE ACTION OF BURIED RADIUM ON DISEASED THYROIDS IN MAN

BY J. O. BOWER, M.D., F.A.C.S., AND J. H. CLARK, M.D.

Departments of Surgery and Pathology, Temple University Medical School

PHILADELPHIA, PENNSYLVANIA

WE HAVE previously reported experimental work on the implantation of radium needles in the thyroids of dogs.[1] Our results indicated that normal thyroid tissue is resistant to the action of unscreened radium rays and we feel that, owing to this resistance, implantation of radium needles for a comparatively long period of time is a better therapeutic measure in man than surface applications. In addition to our experimental biologic evidence certain physical facts must be borne in mind in making this deduction. First, the action of radium is intensified many times by burying it in tissue, since one obtains the necrotizing action of the beta rays in addition to the effect of the gamma rays. Furthermore, the action of the gamma rays diminishes with the distance, as the square of the distance.

Witherbee[2] gives his *x*-ray dosage for the treatment of tonsils, adenoids and goiter as a 7-in. spark-gap, 5 ma., 10-in. distance, four minutes' time, the rays being filtered through 3 mm. of aluminum. While we are not in a position to compare accurately the dosage, one may get a fair idea by comparing the potential of surface application of radium with that of *x*-rays, which is 1,000,000 volts radium as compared with the maximum 200,000 for *x*-rays, a 20-in. spark-gap being essential. If we consider the proper dosage for surface application to be 1,600–3,000 mgm. hrs. (radium applied 2½ cm. from skin surface) then, according to Viol[3] and others, the outlying cells, those farthest away from the action of the radium rays, will receive sixteen times as much radiation with the embedded radium as with the surface application.

These facts have led us to employ larger doses of buried radium in thyroid disease and the clinical results obtained so far seem to justify the procedure.

Terry,[4] has reported very favorable results in exophthalmic goiter from the use of buried radium emanation tubes, but used doses much smaller than we have employed, while several men have obtained good results from surface applications. Abbe,[5] was the first to use buried radium in exophthalmic goiter and employed in a single reported case the massive dose of 2,400 mgm.

We wish to report briefly 3 cases of thyroid disease, each differing from the others, in all of which we employed comparatively large doses of buried radium.

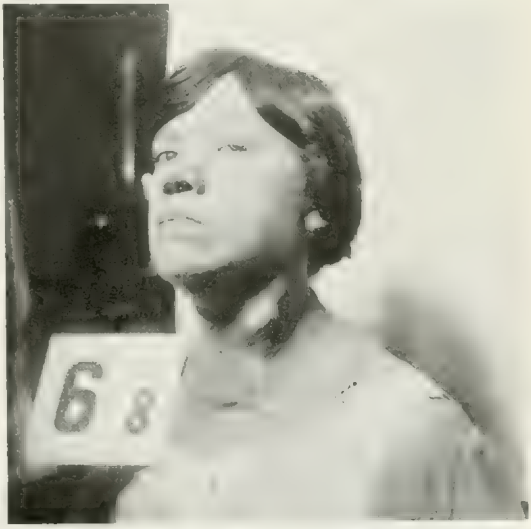


FIG. 1. Case I. May 28, 1922. Recurrent carcinoma of thyroid before radium treatment.

In two the diagnosis was confirmed by histologic examination of tissue.

Case I is one of recurrent carcinoma of the thyroid (Figs. 1–6).

Case II is one of simple colloid goiter (Figs. 7–9) complicated by carcinoma of the larynx with a slightly increased basal metabolic rate, decreasing under radium treatment.

Case III represents a rather typical toxic goiter, not confirmed by histologic examination, but which shows a clinical cure within six months after two doses of buried radium (Figs. 10–11).

CASE I. Female.

Family History. Negative.

Previous Personal History. Negative.

Menstrual History. Normal until March 9, 1922, when the flow became profuse. This was of three weeks' duration and unaccompanied by pain.

Present Illness. In January, 1919, patient developed tonsillitis which confined her to bed for several days. About two weeks later, she noticed a swelling in the anterior aspect of cervical region, left. About February 1st, of the same year, this had attained the size of a hen's egg. Patient stated that it was painless; that it moved when she swallowed and that she noticed no change in her eyes at that time. About February 1, 1922, the swelling increased in size very rapidly. This was accompanied by severe pain, especially in bad weather. About this time she noticed that her eyes became more prominent, that her heart beat more rapidly and that she became rather nervous. On May 3, 1922, she consulted Dr. W. W. Babcock, who advised operation. This was done at the American Stomach Hospital, May 9, 1922, under local anesthesia. The growth measured 10 × 7 × 3 cm., and on section appeared sarcomatous in nature. Microscopic examination, however, by one of us, disclosed it to be carcinoma (Figs. 2–5). On May 8, 1922, the patient was referred to one of us with a recurrence of a growth on the left anterior cervical region anterior to the sternomastoid. The growth measured 5 × 4 × 2 cm. In the center of the necklace incision was a granulating area about 1½ cm. in diameter.

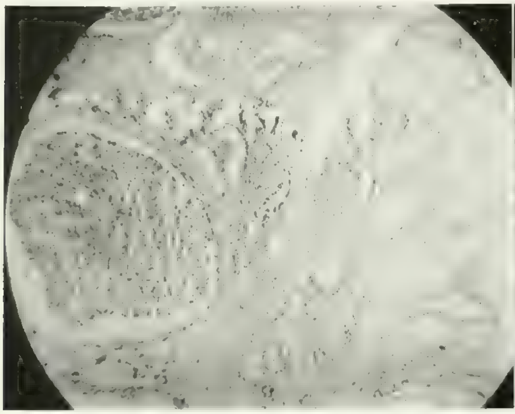


FIG. 2. Case I. Low-power photomicrograph near edge of advancing carcinoma. Some follicles contain colloid, others are filled with proliferated epithelium. Compare with Figure 3.

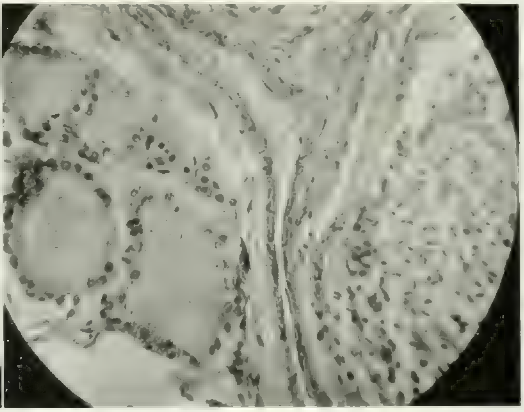


FIG. 3. Case I. High-power photomicrograph near edge of advancing carcinoma. Compare with Figure 2.

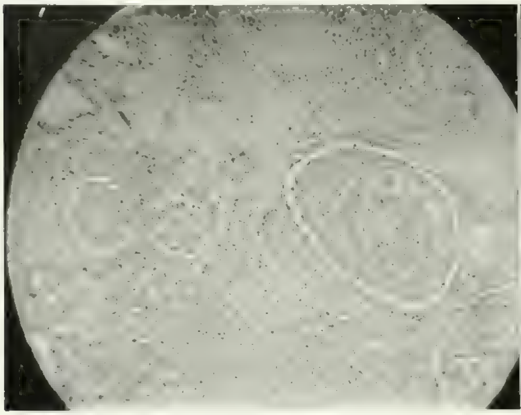


FIG. 4. Case I. Low-power photomicrograph of fully developed carcinoma. Compare with Figure 5.

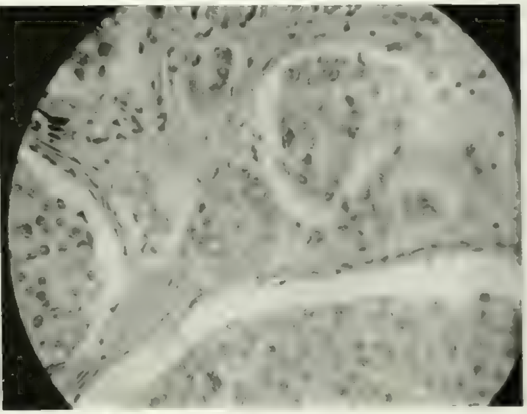


FIG. 5. Case I. High-power photomicrograph of fully developed carcinoma. Compare with Figure 4.

On May 28, 1922, two 12½-mgm. needles were inserted into the growth and 25 mgm. placed directly over (26 mm. distant) for a period of forty-eight hours, and 25 mgm. over the granulating area in the center of the incision. At the end of three weeks the granulating area had healed and the growth had diminished one-half in size. At this time 25 mgm. were again inserted into the growth twenty-six hours. At the end of two months it had diminished to one-third its size, and at the end of three months had disappeared except for a moderate amount of induration.

Subsequent History. About six months after application, patient suddenly disappeared and all efforts to locate her have been unsuccessful.

Case II. Male, aged forty-seven years. Entered hospital December 11, 1922.

Complaint. Hoarseness of voice.

Family History. Negative.

Past Personal History. Negative.

Present Illness. First noticed hoarseness in July, 1922; since that time he has lost 4 lbs. in weight. Two years previously had noted a swelling in the lower part of his neck which has gradually increased in size.

Physical Examination. Height 65 in.; weight, 117 lbs.; caries and pyorrhea; enlarged tonsils; thyroid enlarged, irregular and pulsating. Heart rapid, 180; blood pressure 125–80; blood count 3,960,000 reds, 5,800 whites; hemoglobin 70; polymorphonuclears 67; lymphocytes, small 27; large 2; mononuclears 2; transitionals 2; Wassermann negative; sputum negative for tubercle bacilli. Urinalysis negative; examination of larynx showed a small whitish pedunculated mass about 12 × 6 × 4 mm. lying between the vocal cords. This, on a second laryngoscopic examination, was spontaneously coughed up and proved to be a squamous-cell epithelioma. Basal metabolic rate, January 1, 1923, was plus 44. January 16, 1923, plus 28. On January 27th, 1923, under local anesthesia, a 6 cm. horizontal incision was made over inferior portion of left lobe of thyroid; the ribbon muscles were retracted and eight 12.5 mgm. needles inserted into the gland. Radium was removed at the end of twenty hours. March 8, 1923, gland was about half original size; voice slightly improved. Laryngoscopic examination shows growth to be about one-half former size. Basal metabolic rate plus 17½. Five 12.5 mgm. needles were again inserted into the thyroid gland for twenty-four hours and 37.5 mgm. placed directly opposite in order to obtain maximum cross-fire effect. Patient discharged from hospital at the end of thirty-six hours.

Remarks. Seven days after re-insertion of radium needles, patient without interrogation remarked that tonsils were very much smaller; that they used to touch each other. No change in size of gland.

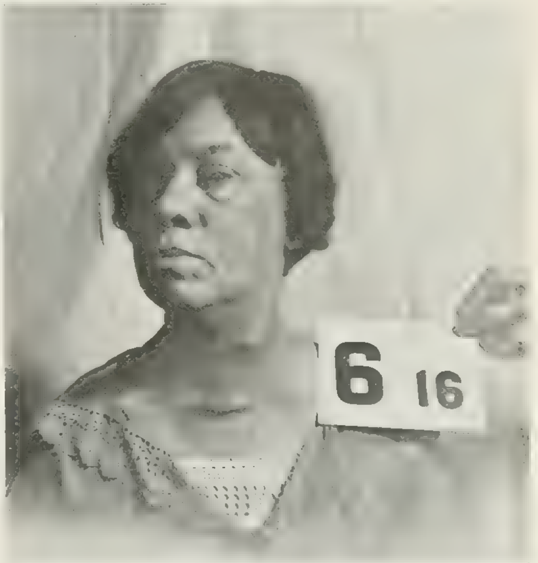


Fig. 6. Case I. August 26, 1922. Photograph three months after initial radium treatment. Area of moderate induration at site of growth. General health much improved.

March 27, 1923, patient returned for observation. Thyroid gland normal in size. Tonsils reduced to one-third original size; growth in larynx very much smaller. Pulse 120; weight 120½ lbs. Voice improved. Surface application 2400 mgm. hrs.

April 17, 1923, thyroid of normal size; tonsils showed no change since last examination; growth in larynx slightly larger. Dr. T. C. Davis of the Nose and Throat Department of the Samaritan Hospital, Philadelphia, devised a specialapplicator for introduction of radium directly to the growth, but it was impossible to keep it in position for more than a few minutes. In order that direct application could be made to the growth, tracheotomy was advised, and the patient at the present time has this under consideration.

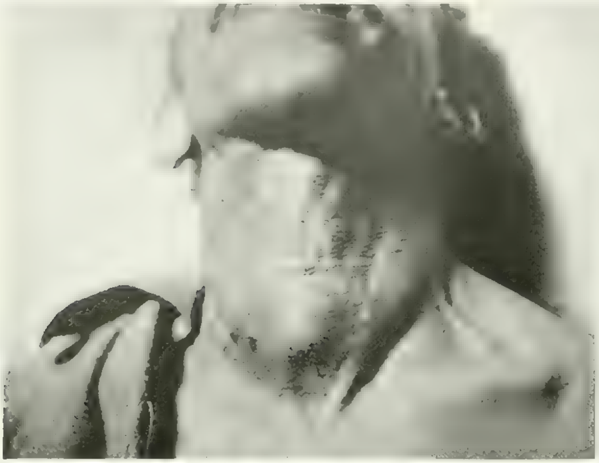


Fig. 7a. Case II. Photograph before implantation of radium needles.

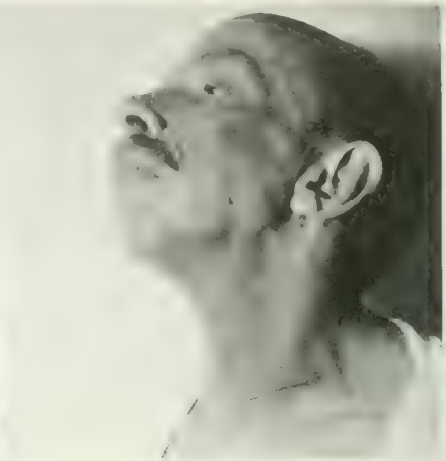


Fig. 7b. Case II. Photograph after implantation radium needles.

In this case it was thought that the thyroid was involved in the malignant process; unfortunately, a section of the gland was not removed at the initial radium treatment. The section removed one month later showed no malignant change (Fig. 8). The second application was not necessary from the standpoint of treating the goiter, but it was decided that the maximum radiation of the laryngeal growth could be attained with the needles in this position.

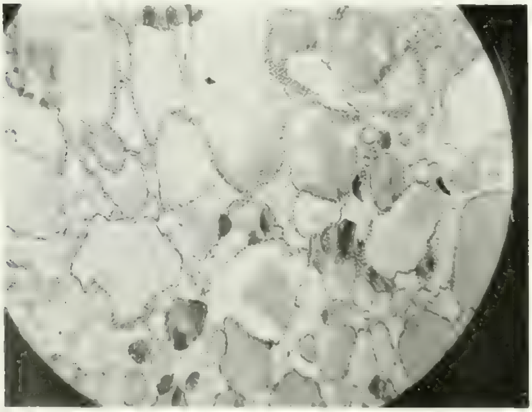


Fig. 8. Case II. Note irregular-sized follicles, flattened epithelium and irregular distribution of colloid.

Case III. Male, aged thirty-six years.
Family History. Negative.
Past Personal History. Negative.
Complaint. Loss of weight; nervousness; bulging in neck; diarrhea.

In November, 1922, patient developed within a few days a globular swelling in the left anterior cervical region about the size of a small orange. He became nervous; complained of palpitation, dyspnea after exertion, epigastric discomfort immediately after eating, sour eructations, fulness and a persistent diarrhea.

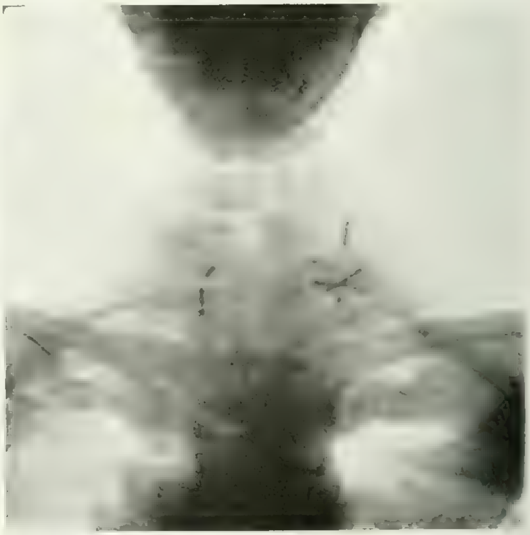


Fig. 9. Case II. Showing radium needles in enlarged isthmus and left lobe of thyroid.

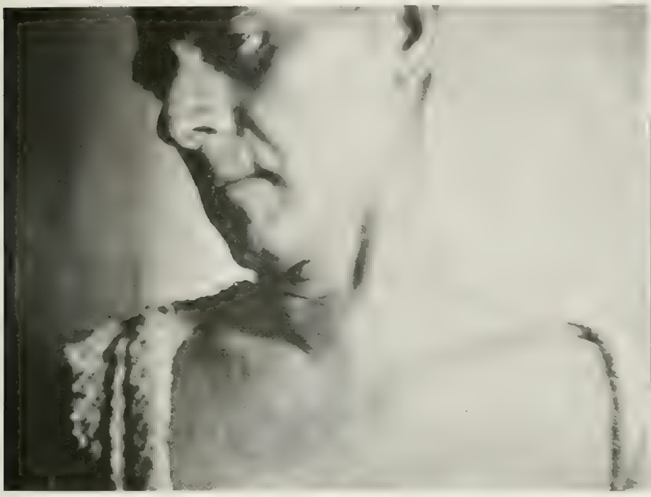


Fig. 10*a*. Case III. Photograph showing patient before implantation of radium needles.

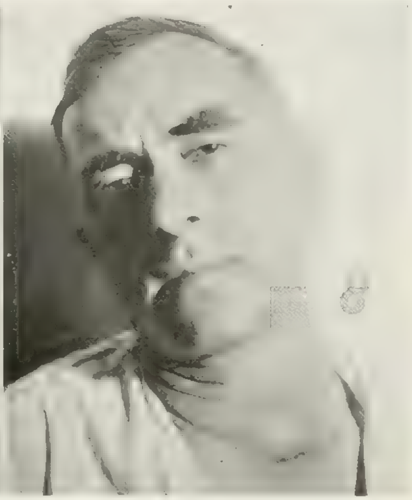


Fig. 10*b*. Case III. Photograph showing patient three months after implantation of radium needles; patient has gained 31 lbs.

Physical Examination. Showed what appeared to be an adenomatous growth of the thyroid about 7 cm. in diameter. Area of heart dulness increased to the left. Pulse rate, 140; blood pressure—systolic 140, diastolic 80. There was a marked tremor and sweating of the hands. Basal metabolism was attempted on seven occasions but patient was extremely nervous and results were unreliable. Patient, being of Italian origin, could speak but little English and we were unable to assure him of the harmlessness of the procedure.

December 19, 1922, under local anesthesia, eight 12.5 mgm. radium needles were inserted into the enlarged lobe of the thyroid, using a special applicator devised by Dr. Cameron of the Radium Chemical Company of Pittsburgh. They were withdrawn at the end of ten hours. The patient left the hospital at this time. Wounds healed primarily.

On examination, December 26, 1922, skin showed slight reaction; no change in size of thyroid. Pulse 120; symptoms unchanged.

January 3, 1923, goiter slightly smaller; pulse 108; other symptoms unchanged.

January 19, 1923, after considering our own and the experience of others, in injecting the thyroid with quinine and urea (since in a large percentage of instances subsequent operation disclosed that the quinine and urea supposedly injected into the gland usually reached only the capsule) it was decided that it would probably be better to expose the thyroid and insert the radium directly into the gland proper. This was done, making a 6-cm. incision, about 1 cm. above the upper border of the

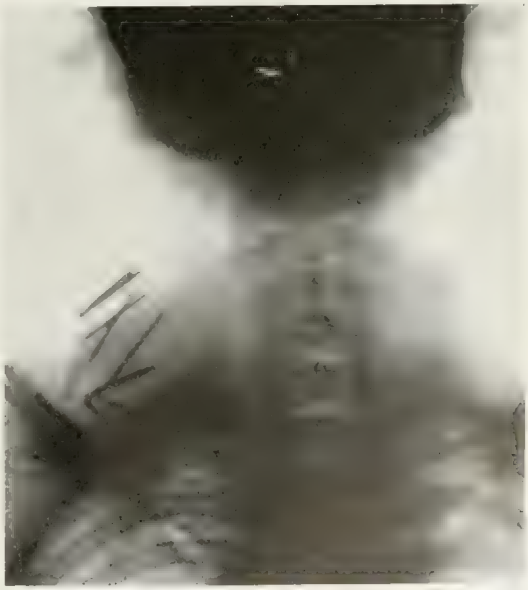


Fig. 11. Case III. Showing radium needles embedded in left lobe of thyroid.

clavicle. We were unable to find any evidence or show that the capsule had been penetrated by the needles. There was evidence of muscle change but no adhesions could be found. Eight 12.5-mg. needles were inserted directly into the gland after retraction of the neck muscles. They were removed at the end of twenty hours.

February 2, 1923, wound healed without complication. No change in size of growth pulse 108; sweating of hands somewhat diminished; diarrhea has subsided.

March 1, 1923, patient feeling much better; has returned to work. Growth in neck much smaller; pulse 90; bowel, movements normal; tremor less. No sweating of hands.

April 15, 1923, improving in health; gained 15 lbs.; growth has almost disappeared; pulse 84; digestion good; bowels move normally; no tremor.

May 15, 1923, patient has gained 30 lbs.; never felt better; working eight hours daily; pulse 80; no tremor; digestion good.

Remarks. In order to be certain that any result obtained in this case was due to the action of the radium alone, the patient was not put at rest. For the two treatments he was confined to bed thirty hours. He was given no medication and was permitted to eat anything. It will be noted that the improvement began about the time cicatrization was completed.

CONCLUSIONS

1. Three different types of thyroid disease are reported in which large doses of buried radium were employed.

2. The large dose was well borne and gave no untoward symptoms.

3. The use of buried radium needles is a feasible therapeutic measure and gives reliable results. We believe that radium is far superior to the injection of boiling water, quinine and urea, or polar ligation; that it is indicated in cases that are poor operative risks.

4. Owing to the apparent resistance of thyroid tissue to radium rays, as found from experimental work, it is urged that those using radium in thyroid disease employ comparatively large doses of buried element.

BIBLIOGRAPHY

1. Bower and Clark. Am. J. Roentgenol., Aug., 1923, x, No. 8, 632.
2. Witherbee, W. D. The dosage and technique in the *x*-ray treatment of goiter, tuberculous glands of the neck, tonsils and adenoids. Am. J. Roentgenol., Aug., 1922, ix, 514.
3. Viol. Personal correspondence.
4. Terry, W. I. *J. Am. M. Assn.*, 1921, lxxvi, 1821. *J. Am. M. Assn.*, 1922, lxxix, 1.
5. Abbe, Robt. *Arch. Roentg. Ray.* 1905, ix, 214.

A COMPARATIVE STUDY OF THE EFFICIENCY OF VARIOUS FILTER MATERIALS[*]

BY ARTHUR W. ERSKINE, M.D., AND SCOTT W. SMITH, M.S.

CEDAR RAPIDS, IOWA

A FILTER is an absorber. Its efficiency depends upon the fact that it absorbs *x*-rays in proportion to their wave-lengths, that is, it absorbs proportionately fewer short than long waves. The ideal filter would absorb *all* rays of more than the desired wave-length, but would not absorb any rays of shorter length. Our problem is to determine what filters approach most nearly the ideal, or, what filters absorb the maximum of long waves and the minimum of short ones. The obvious method to be employed in such a comparative study would be to interpose various filters in the path of a beam of *x*-rays, produced under fixed conditions, and then by analyses of the spectra of the filtered beams, determine the effects of the filters upon wave-length. The technical difficulties of such a method are great, and a moment's reflection shows one that a much simpler and more direct solution of the problem is available. We endeavor to obtain a beam of *x*-rays with a high proportion of short wave-lengths, not because there is any especial therapeutic virtue in short wave-lengths, but because they are more penetrating. Since penetration is inversely proportional to wave-length we can omit all measurements of wave-length, and confine our study to the effect of various filters on penetration. The degree of penetration can be shown by the ratio between the surface and depth intensities in a water-phantom. It is proper to assume that the most nearly ideal filter will be the one which permits the delivery of the highest percentage of surface radiation to the depth, when compared to other filters which equally increase the length of time required for the administration of a surface dose.

In accumulating the data for this study, the voltage, current, size of field and anode surface distance were fixed. Readings were made of the time required to discharge the electroscope with the ionization chamber at the surface of a water-phantom and at a depth of 10 cm., using unfiltered rays first, and then gradually increasing thicknesses of the various filter materials investigated. From these readings two graphs were plotted for each filter (Figure 1). The one which we may, for convenience, call the surface dose, shows how the time in seconds required to discharge the electroscope with the ionization chamber at the surface of the water increases with the addition of each layer of filter. The graph called, for convenience, the depth-dose percentage, shows how the percentage of the surface dose reaching a depth of 10 cm. increases with the addition of each layer of filter. The points on the latter graph are obtained by dividing the number of seconds required to discharge the electroscope with the ionization chamber at the surface by the time in seconds required to discharge the electroscope with the ionization chamber at the depth. From the surface-dose graph we may also determine what part of the original beam of *x*-rays is absorbed by any given thickness of filter, and what thickness of filter is required to absorb any given percentage of the original beam. For

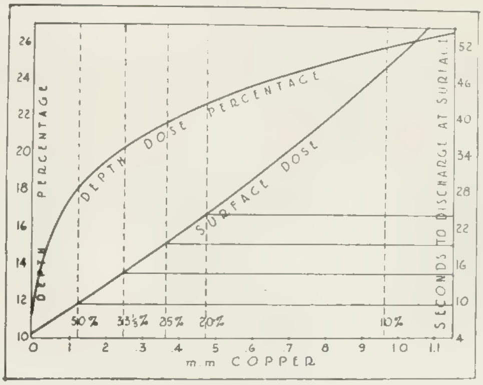


FIG. 1. Specimen graph showing the surface dose and the depth dose percentage with various thicknesses of copper. 140 kv., 2.5 ma., 10 cm. field, and 40 cm. anode surface distance.

---

[*] Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

example, when enough filter has been introduced to reduce the rate of fall of the gold leaf of the electroscope to one-half what it was when no filter was used, it is evident that 50 per cent of the original beam has been absorbed. If the electroscope discharges only one-fourth as rapidly as when no filter is used, three-fourths of the beam has been absorbed and only 25 per cent remains. By comparing the depth-dose percentage graphs of two or more filter materials at points where equal percentages of the original beams have been absorbed, the relative efficiency of the materials is easily shown.

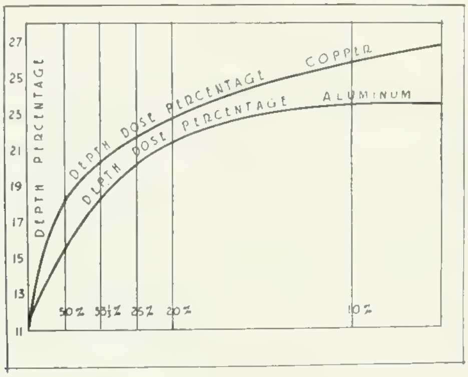


Fig. 2. Comparative depth dose percentage graphs with copper and aluminum filters, plotted according to their absorption values. 140 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

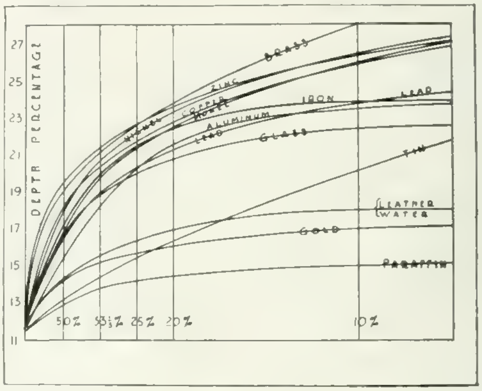


Fig. 3. Comparative depth dose percentage graphs with various filter materials, plotted according to their absorption values. 140 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

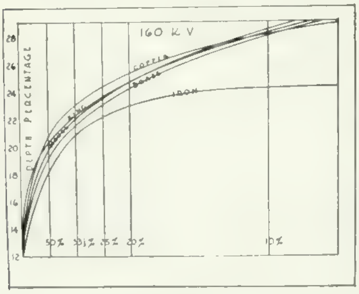


Fig. 4. Depth dose percentage graphs of the more efficient filters. 160 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

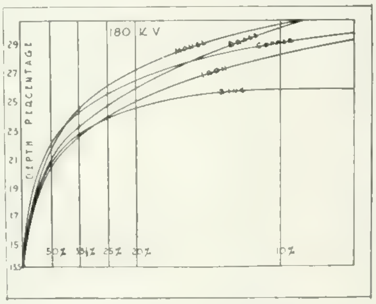


Fig. 5. Depth dose percentage graphs of the more efficient filters. 180 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

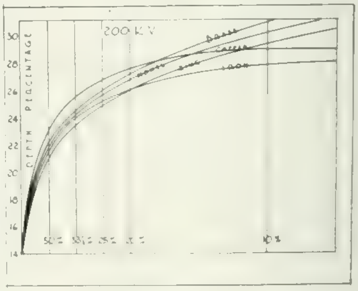


Fig. 6. Depth dose percentage graphs of the more efficient filters. 200 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

In Figure 2 the depth-dose percentage graphs of aluminum and copper are both plotted according to the absorption values of the materials instead of their actual thickness. When enough aluminum has been introduced to reduce the intensity of the unfiltered beam to 50, 25 and 10 per cent, respectively, the depth-dose percentages are 15.5, 20.1 and 23.4, respectively. Corresponding depth-dose percentages with copper filters are 18.1, 21.7, and 25.8, respectively; showing that copper is considerably more efficient as a filter than aluminum.

In Figure 3 the depth-dose percentage graphs of all the materials studied are plotted according to the absorption values of the materials. The more efficient filters are the elements, copper, iron, nickel and zinc, and their alloys, brass and monel metal. The atomic weights of these elements range from 55 to 65, and their atomic numbers from 25 to 30. Elements with higher or lower atomic weights and atomic numbers are less efficient.

Table I.—Depth Dose Percentage

Material	At. Wt.	At. No.	50 Per Cent	33⅓ Per Cent	25 Per Cent	20 Per Cent	10 Per Cent
Brass	.....	.....	19.0	21.0	22.5	23.8	28.0
Zinc	65.4	30	19.2	21.3	22.6	23.7	26.2
Nickel	58.7	28	17.8	20.6	22.2	23.2	26.2
Copper	63.6	29	18.1	20.3	21.7	22.7	25.8
Monel	.....	..	16.5	19.7	21.3	22.5	25.8
Iron	55.8	26	16.9	19.6	21.4	22.5	23.8
Aluminum	27.1	13	15.5	18.3	20.1	21.5	23.4
Lead	207.2	82	16.4	18.8	20.2	21.2	23.6
Glass	.....	..	17.2	18.8	19.9	20.6	22.3
Leather	.....	..	14.4	15.6	16.4	16.9	17.8
Water	.....	..	14.2	15.5	16.4	16.8	17.8
Gold	197.2	79	14.5	15.1	15.5	15.9	17.0
Tin	118.7	50	12.5	14.2	15.5	16.5	20.1
Paraffin	.....	.....	13.3	13.8	14.1	14.3	14.9

All the foregoing data were obtained by measurements of *x*-rays produced at 140 kv., 2.5 ma., diameter of field 10 cm., and anode surface distance, 40 cm. The measurements were repeated with the more efficient elements and alloys at 160, 180 and 200 kv., the results being shown in Figures 4, 5 and 6 respectively.

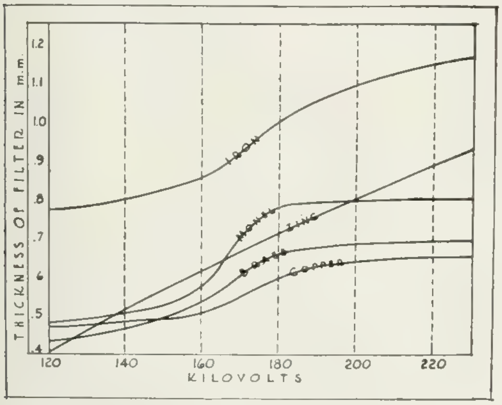


Fig. 7. Thicknesses of copper, iron, zinc, brass and monel metal absorbing 80 per cent of the total beam of *x*-rays at various voltages.

An interesting fact which can be demonstrated on all the graphs, with all the materials and voltages studied, is that the limit of economical increase in filter thickness varies with the voltage. It corresponds approximately to the thickness which will absorb 80 per cent of the unfiltered beam of *x*-rays, or to express it differently, is the filter thickness which multiplies the time of the unfiltered dose by five. The thicknesses of the various more efficient elements and their alloys which will absorb 80 per cent of the unfiltered beam at various voltages are shown in Figure 7.[1]

SUMMARY

1. Since filter efficiency depends upon the wave-lengths in the filtered beam, and since penetration is inversely proportional to wave-lengths, the relative efficiency of various filter materials may be determined by a comparison of their effects on penetration.

2. Such a comparison may be made by measuring the effect of various filters on the ratio between the surface and depth intensities in a water-phantom, provided that the *x*-rays measured are produced under fixed conditions.

3. The most efficient elements studied are copper, iron, nickel and zinc, ranging in atomic weights from 55 to 65, and in atomic numbers from 25 to 30.

4. The most efficient alloys studied are brass and monel metal, which are alloys of the same elements.

5. Because of the efficiency and desirable physical properties of the alloys they should receive further study and investigation.

---

[1] The experimental work of this investigation was performed in the radiological research laboratory of Coe College, under the general supervision of Dr. L. D. Weld, of the Department of Physics.

A WATER-COOLED HIGH-VOLTAGE X-RAY TUBE*

BY W. D. COOLIDGE, PH.D., AND C. N. MOORE

Research Laboratory, General Electric Company

SCHENECTADY, NEW YORK

I. INTRODUCTION

IN a paper read before the Radiological Society of North America in December, 1922, one of the authors described experimental tubes in which the anode consisted of a solid plate of tungsten in the form of a circular disc 4 in. in diameter. These tubes were operated in water-cooled oil and ran steadily with as much as 50 ma. at 200,000 volts. On life-test, one of them ran continuously for forty hours with 30 ma. at 200,000 volts and was still operable.

An interesting difficulty manifested itself when these tubes were operated continuously. The inner surface of the glass became roughened locally and in places serious erosion developed. It was suggested that this action might be due, primarily, to an electrolysis of the hot glass of the bulb, and secondarily, to positive ion or other bombardment resulting from the continuous evolution inside the bulb of the products of such electrolysis.

While the experiments already referred to indicated that a satisfactory high-power tube of the type in question could be made, it appeared desirable to see whether there was not some easier solution of the problem. With this end in view, work was undertaken, and finally carried to a successful conclusion, on a high-power high-voltage tube with a water-cooled anode.

Some work had already been done on a high-power water-cooled tube for lower voltages and in 1915 one of the authors had reported on this work.[1] Excellent performance had been obtained with tubes carrying as much as 100 ma. at 140,000 volts (max.) Only one serious difficulty had been encountered in this work and this was in connection with the target. On continuous operation, minute cracks would develop in the target metal in the neighborhood of the focal spot, and these cracks would gradually deepen until they finally extended through the tungsten face of the target and through the copper backing. These cracks permitted water to leak right into the tube. The effect was due to the forces of expansion and contraction brought into play by the intermittent character of the (alternating current) discharge. The tube was operating on 60 cycle alternating current, and, as a result of this, 60 times per second the target face was heated and caused to expand and 60 times per second this heated metal was chilled by the cooling water applied to the back of the target, and caused to contract.

2. THE TUBE

Before attempting to design a water-cooled target for a high-voltage tube, a study was made of the water-cooled tube referred to in the preceding paragraph. It was found that, in general, the tearing action of the discharge was greater the higher the temperature gradient in the target. This is illustrated by the fact that one tube had shown a life of 1,500 hours with a load of 50 ma. at 70,000 volts (max.) and that the target of this tube was still intact, whereas another tube with this same target design had shown a target life of less than one hundred hours when operated at 100 ma. and 70,000 volts (max.), that is, with essentially only twice the temperature gradient in the target.

To reduce the temperature gradient in the target of the new tube, the focal spot area was greatly increased and three different designs of target were tried (Fig. 1). In the first (A) a section of small seamless copper tubing was wound around and silver-soldered to a cylinder of copper with a tungsten plate cast in one end. In the other two (B and C) square or round copper tubing was wound up in the form of a spiral and silver-soldered to the back of a thin disc of copper carrying a thin tungsten plate cast in the face. The two latter types possess the advantage of lighter weight, more uniform temperature gradient between focal spot and water, and easier construc-

---

[1] Coolidge, W. D., Am. J. Roentgenol., Jan., 1914, i, 115.

* Read at the Twenty-fourth Annual Meeting of The American Roentgen Ray Society, Chicago, Ill., Sept. 18–21, 1923.

tion. Type C proved somewhat easier to construct that B owing to the fact that the round tubing could be more easily brought into the required form without producing undue strains which might lead to cracks.

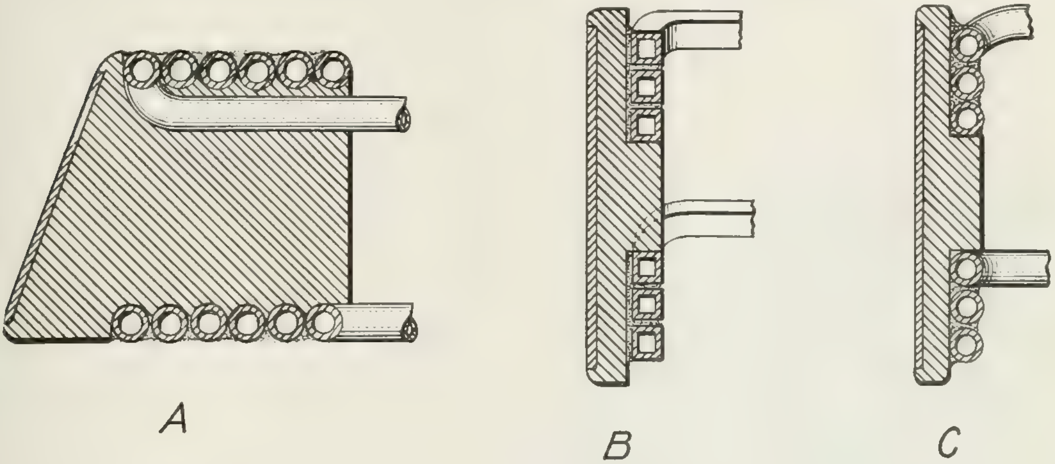


Fig. 1. Three types of water-cooled anode (natural size).

A complete tube with an anode of Type C is shown in Figure 2. The ends of the copper tube coming from the back of the target are brought out through a larger copper tube (a) with a vacuum-tight silver-soldered joint at the inner end of (a). The distinctive feature of this construction is the use of a seamless metal tube to conduct the water in and out of the *x*-ray tube, the solder between tubing and target being depended upon only for making thermal contact, and not for making a vacuum-tight joint. The copper tube (a) is joined to the glass tube (b), (the re-entrant portion of the anode arm) by means of the thin platinum sleeve (c). To increase the effective length of the anode arm, a tube of solid dielectric (d) is slipped over the small copper tubes and held in place by means of the cap (e) of insulating material which is cemented to the outer end of the arm.

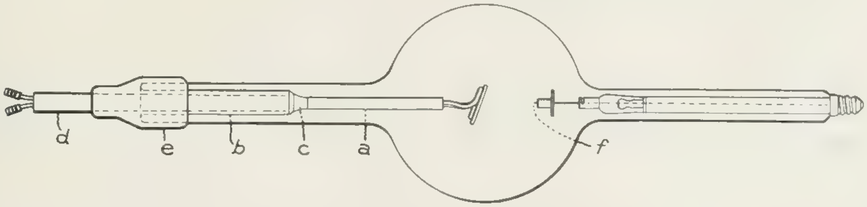


Fig. 2. Water-cooled high-voltage tube.

The glass bulb is 8 in. in diameter.

The cathode is the same as that found in the Universal type of tube except that a small projecting pin (f) of molybdenum has been located in the center of the filament spiral, the function of the pin being so to change the electric field about the cathode as to produce a large focal spot.

A pinhole-camera picture of the focal spot of one of these tubes is given in Figure 3. In this case the focal spot was $1\frac{1}{8}$ in. in diameter.

3. GENERATING OUTFIT

The operation of such a water-cooled tube at high currents and voltages was found to be most satisfactory on a generating outfit consisting essentially of a high-tension transformer, rectifying switch and resistance control.

The most suitable transformer used was a large experimental one designed especially to give close regulation. The switch was of the four-arm type and utilized about 70 per cent of the wave. When the tube was operating at 50 ma. and 250,000 volts, sufficient ballast resistance was used in the control to reduce the voltage from 250 (line voltage) to about 195 (55 volts being consumed in the resistance).

4. ACCESSORIES

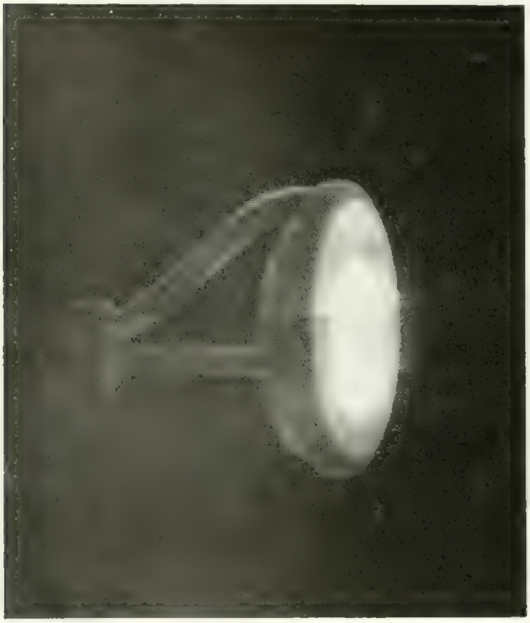


FIG. 3.

For the operation of a high-voltage water-cooled tube, an insulated water system is desirable. The experimental installation employed (Fig. 4) consisted of a No. 23 Brown and Sharpe bronze gear pump (a) driven by motor (b) through an insulating shaft (c), and a cellular type Ford radiator (d) cooled by air forced through a tunnel (e) made of insulating material, from an 18 in. Davison blower (f). Water connections between pump and tube, and between tube and radiator, were made through flexible tubing (g).

The pump was driven at such a speed that it circulated about 4 liters of water per minute through the anode at about 30 lbs. pressure. With a tube load of 50 ma. at 250,000 volts, the temperature of the water as it left the anode was 70°C. and the temperature was lowered to 50°C. in the radiator. A gear pump was chosen in preference to a centrifugal pump because it assured a continuous flow of water, and furthermore, gave the pressure necessary to force sufficient water through the small copper tubing.

It was necessary to provide some means for guarding against failure of the water circulation while the tube was operating, as such failure would involve the immediate destruction of the target. This assurance of an uninterrupted water supply was secured by installing a section of Sylphon tube (f) on the high-pressure side of the pump and connecting one end of the Sylphon chamber of a rod (i) operating contacts (j) in the circuit of a relay which controlled a contactor located in the primary circuit of the *x*-ray transformer.

Details of this safety device are given in Figure 5. It is evident from this diagram that, unless the contacts (a) are brought together by expansion of the Sylphon tubing (b) due to pressure of the circulating water, the contactor (c) will not be operated and current cannot pass through the primary of the *x*-ray transformer (d).

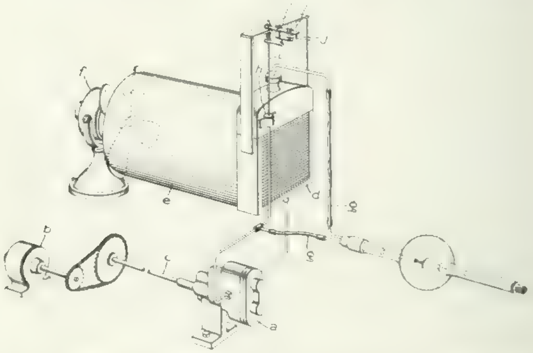


FIG. 4. Water-cooled high-voltage tube and accessories.

A similar safety device to assure sufficient cooling of the water might be designed to be operated by air from the blower or by the temperature of the water itself.

5. CAPACITY OF THE TUBE

Tubes of the type described above have been operated in the laboratory at 50 ma. and 250,000 volts max. This was a load of approximately 9 kilowatts. One tube was operated for 50 hrs. at this load without any change in the behavior of the tube.

With suitable design, this type of tube could apparently be made to handle even much larger amount of energy.

6. X-RAY OUTPUT

With such a high-power tube, it became interesting to measure the *x*-ray intensity delivered when operating with various tube currents and at different voltages. This was done with an ionization chamber and a gold leaf electroscope, the measurements being made under a 1 mm. filter of copper. The graphs shown in Figure 6 give the *x*-ray intensity, expressed in arbitrary units, obtained with tube currents of from 1 to 50 ma. and voltages of 200,000 and 250,000 (max.). The graphs are not straight lines and indicate that, over this wide range of current, *x*-ray intensity at a given voltage was not proportional to milliamperage.

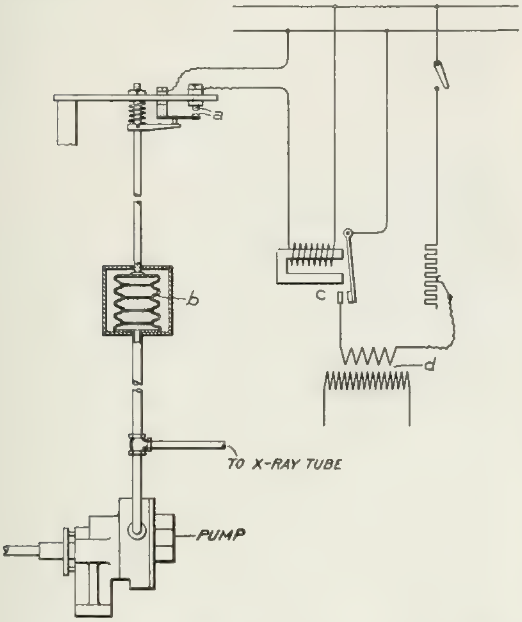


Fig. 5. Diagram of safety device to prevent closing of *x*-ray circuit without water flowing through tube.

It seems very probable that there is a distortion of wave form, increasing with load, and that this distortion is of such a nature as to decrease the efficiency of *x*-ray production.

It seemed worth while to study the relation between energy input and *x*-ray output. Most of the energy in the high-tension current delivered to the *x*-ray tube is converted in the target into heat, and a measurement of the temperature of the water, as it enters and as it leaves the target, together with a measurement of the amount of water flowing through the target, gives data from which the energy input may be calculated. Such measurements were made with the various tube-currents employed in making the above-mentioned intensity curves at 250,000 volts. The data are given in Table 1 and the energy values taken from the last column are plotted on the upper curve in Figure 7. Beside this curve is given the *x*-ray intensity curve for the same voltage. (The values for the curve given in Figure 6 were multiplied by an amount necessary to make the two curves coincide at the 50-ma. point.) The two curves are practically identical, showing that the *x*-ray output, as measured in the manner already described, was very closely proportional to energy input.

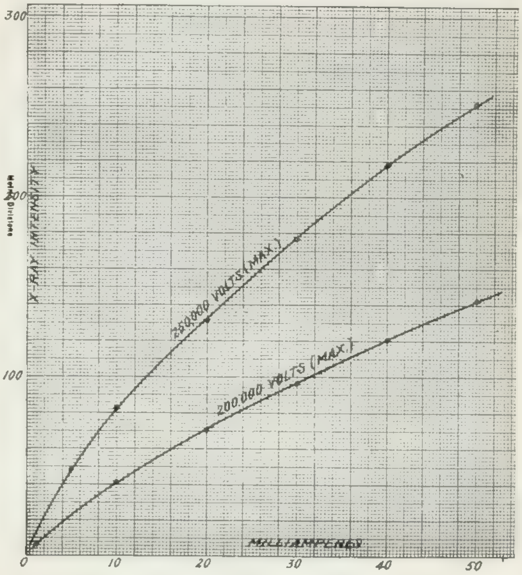


Fig. 6. Curve showing relation between *x*-ray intensity and milliamperage.

7. EFFECT OF GENERATING OUTFIT ON X-RAY OUTPUT

Various high-tension transformers, rectifying switches and controls, and various types of generating outfits were used with the water-cooled tube, and, as a result of this experience, the following general conclusions may be drawn:

(*a*) The electrical characteristics of the generating outfit have a marked effect upon the behavior of the system and upon the *x*-ray output.

(*b*) With the interrupterless type of machine, the system operates best when a large amount of ballast resistance is used in the low-tension circuit of the *x*-ray transformer. With auto-transformer control and no ballast resistance, bad surges take place.

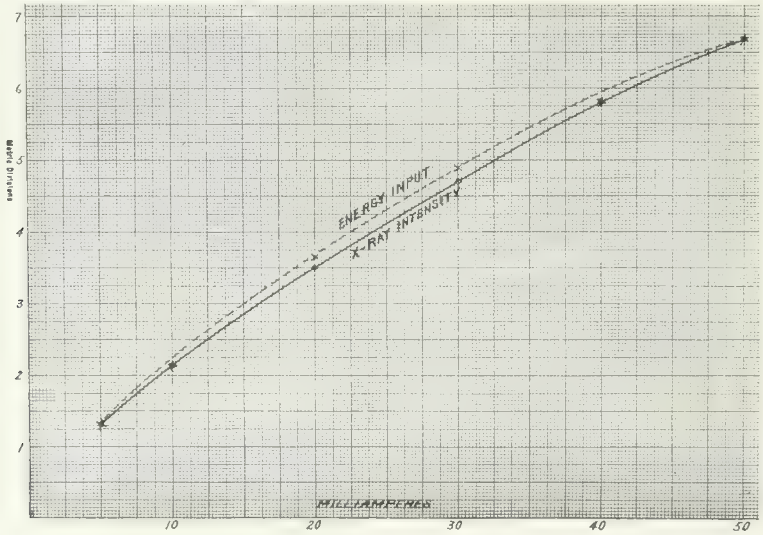


Fig. 7. *X*-ray intensity and energy input at 250,000 volts (max.).

(*c*) With the interrupterless type of machine, with the same switch and the same control, the *x*-ray output, for the same milliamperage and voltage, is different with different high-voltage transformers.

(*d*) With a constant-potential continuous-current outfit[1] the *x*-ray output is greater, for the same values of tube current and voltage, than it is with the interrupterless type of machine.

(*e*) When rectifying its own current, the tube does not operate satisfactorily with as high voltages as it will satisfactorily handle on rectified current.

Data obtained in making *x*-ray intensity measurements with the Universal type high-voltage tube and the water-cooled tube operating on various types of generating apparatus are given in Table II. The measurements were made with the ionization chamber 1, under 1 mm. of copper filter.

In 1, the next to the last column of the table, is given a number of ratios of *x*-ray intensities.

From the first group 1 it is seen that under the same conditions, the Universal high-voltage tube and the water-cooled tube give the same *x*-ray intensity.

From 1, 2, 3, 4 and 5 the following conclusions may be drawn:

In terms of the *x*-ray intensity delivered by the Universal type high-voltage tube when operated at 5 ma. and 200,000 volts (which is perhaps the average current and voltage employed with this tube) the water-cooled tube gives:

At 30 ma. and 200,000 volts, 4.30 times as much *x*-ray intensity.

At 30 ma. and 250,000 volts, 8.27 times as much *x*-ray intensity.

At 50 ma. and 250,000 volts, 14.1[1] times as much *x*-ray intensity.

At 50 ma. and 250,000 volts, 15.1[1] times as much *x*-ray intensity.

According to 6 the constant-potential continuous-current machine, operating the water-cooled tube at 10 ma. and 200,000 volts, gives 1.82 times the *x*-ray intensity obtained from the interrupterless type of machine when operating the tube at 10 ma. and 200,000 volts (max.).[1]

---

[1] Coolidge, W. D., and Kearsley, Jr., W. K. High voltage *x*-ray work. Am. J. Roentgenol., Feb., 1922, ix, 77.

[1] Note that two different transformers are involved in these ratios.

8. APPLICATIONS

1. *Medical. Therapy.* In the preceding section it has been shown that there may be obtained with the water-cooled tube under certain conditions an *x*-ray intensity fifteen times as great as that usually obtained with the Universal type high-voltage tube. The question of the desirability of such an increase in *x*-ray intensity in therapeutic work must, of course, be left to the medical profession.

The tube can also be used with the lower values of current and voltage now generally employed, and experience may show that it has a sufficiently longer life than that of the Universal type high-voltage tube to justify the added complications inherent in water cooling.

The distribution of intensity in the radiated tissues will be somewhat affected by the increase in the size of the focal spot over that ordinarily employed.

2. *Industrial. Metal Radiography.* The same considerations which may make the tube interesting for the medical application apply in the field of metal radiography also.

The tube in its present state of development has a focal spot which is large for radiographic work. It seems probable, however, that a similar tube of equal capacity could be developed with a considerably smaller focal spot.

9. SUMMARY

A new type of tube with a water-cooled anode is described. This tube satisfactorily handles as much as 50 ma. and 250,000 volts and, with suitable dimensions, could apparently be made for much larger amounts of energy.

Generating apparatus and auxiliaries, suitable for operating this type of tube with as much as 50 ma. and 250,000 volts, are described.

The effect of the electrical characteristics of the generating outfit on the behavior of the system and on the *x*-ray output is discussed.

The data given show that, with the high currents and voltages used and the interrupterless type of machine, *x*-ray intensity was not proportional to milliamperage, owing probably to distortion of wave-form. It was, however, essentially proportional to energy input.

Possible medical and industrial applications are discussed.

In conclusion, it gives pleasure to the authors to acknowledge the valuable assistance of Mr. George Hotaling and Mr. Leonard Dempster, in carrying out the work which has been described.

TABLE I

Tube-Current (Milli-amperes)	Temp. Water Entering Tube (T_1) Degs. C.	Temp. Water Leaving Tube (T_2) Degs. C.	$T_1 - T_2$	Liters of Water per Minute	Kilo-watts Input
10	31.7	38.3	6.6	4.8	2.20
20	35.5	46.5	11.0	4.8	3.67
30	41.4	56.3	14.9	4.8	4.96
40	45.9	63.5	17.6	4.8	5.88
50	49.7	69.7	20.0	4.8	6.67

TABLE II

Tube	Generating apparatus	Ma.	Kv. (Max.)	X-ray intensity, I	$\frac{I_a}{I_b}$	Group
Universal high-voltage	A	5	200	0.0185(*a*)	1.00	1
Water-cooled	A	5	200	0.0185(*b*)		
Water-cooled	B	30	200	0.0943(*a*)	4.30	2
Water-cooled	B	5	200	0.0219(*b*)		
Water-cooled	B	30	250	0.1796(*a*)	8.27	3
Water-cooled	B	5	200	0.0217(*b*)		
Water-cooled	B	50	250	0.2718(*a*)	14.1	4
Water-cooled	B	5	200	0.0192(*b*)		
Water-cooled	A	50	250	0.2718(*a*)	15.1	5
Water-cooled	B	5	200	0.0179(*b*)		
Water-cooled	C	10	200	0.0704(*a*)	1.82	6
Water-cooled	A	10	200	0.0386(*b*)		

A = Interrupterless Machine consisting of a four-arm switch, a resistance control and a large transformer designed for very close regulation.

B = Interrupterless Machine consisting of the same switch and control used in A and a smaller transformer.

C = Constant Potential—Continuous Current.

The constants of the measuring device were the same for both members of each group of measurements, but may have changed for the different groups. For this reason, the values of *x*-ray intensity for the same tube load are not the same in the various groups.

---

[1] The voltage with the interrupterless machine having been measured as maximum and not effective voltage, this ratio is to be divided by 1.4 if a comparison between the two machines is to be made on the basis of energy input. It should also be noted that although the constant-potential continuous-current machine may work satisfactorily as a laboratory outfit, it has not yet been developed to a point where it could be considered a reliable piece of apparatus for the doctor's office.

DISCUSSION

Dr. D. R. Bowen, Philadelphia, Pa. I would like to ask Mr. Moore whether the difference in the *x*-ray output of the two interrupterless machines A and B was due to differences in switches, controls or transformers.

Mr. Moore (closing discussion). The difference in the *x*-ray output of the two generating outfits A and B could not have been due to differences in switches or in controls as the identical switch and the identical control were used for both outfits. The only part of these outfits which was not common to both was the transformer. The transformer of outfit A was much larger than that of outfit B and had been designed to give very close regulation. This close regulation doubtless resulted in less distortion of wave-form and hence in higher efficiency of *x*-ray production.

MEASUREMENTS OF THE ABSORPTION COEFFICIENT OF WATER AND ALUMINUM FOR HARD X-RAYS

BY EGON LORENZ, PH.D., AND BORIS RAYEWSKY, PH.D.[*]

Institut für Physikalische Grundlagen der Medizin
Frankfort, Germany

THE absorption coefficient of any radiation, including the *x*-rays, is defined by the following equation:

$$I = I_0 e^{-\mu(\lambda, Z) d}$$

in which I_0 is the intensity of the beam when it enters, and I that of the beam when it leaves, the absorbing medium; d is the layer thickness, e the base of the hyperbolic system of logarithms; $\mu(\lambda, Z)$ is termed the absorption coefficient, the latter being a function of the wave-length λ and the absorbing atom's atomic number Z.

The absorption coefficient consists of two coefficients: the pure absorption coefficient μ and the scattering coefficient σ.

$$\textit{i.e.}: \mu(\lambda, Z) = \mu(\lambda, Z) + \sigma(\lambda, Z)$$

In order to determine the absorption coefficient of the *x*-rays by experiment it would be necessary to work with monochromatic radiation. If there is no such radiation, but a heterogeneous one, this radiation must either be decomposed into a spectrum, or, as would be sufficient for practical purposes, be made by sufficient filtration into such a part of a spectrum that the absorption coefficient would become independent of the absorbing medium's layer thickness. This is what we call "practical homogeneous radiation," and it is always used in deep therapy. For its "dosage" it is absolutely necessary to know exactly the absorption coefficient of water and aluminum.

A great number of measurements of the absorption coefficients in question have already been made. Part of them give us variations from each other; first of all measurements of the absorption coefficient of water, which lately have been executed by Glasser,[1] who—with the same maximum tension (200 kv.)—obtains a value approximately 30 per cent higher than that which is generally used in deep therapy.

The purpose of the following work is to execute as exactly as possible the measurements of the absorption coefficient in water and aluminum for hard *x*-rays, and to try to explain the cause of the differences mentioned above.

In order to get an exact measurement of the absorption coefficient the following must be observed:

The source of radiation has to work constantly and it must be possible to establish it very exactly with respect to its quality and quantity of radiation. The condition of practical homogeneity must be fulfilled by proper filtration.

To characterize the quality of the radiation, i.e., of the practical homogeneous radiation also, the easiest way is to take the limiting wave-length that results from the maximum potential at the tube by the equation of Planck-Einstein:

$$h\nu = eV \text{ or } \lambda_0 = \frac{12.34}{\text{kv.}}$$

---

[1] Following the isodoses charts of Glasser, 200 kv. (peak) .75 Cu. + 1 Al. μ water = .180, λ effect. = .15 Å. U.

As to the ray's path, it must be such that the quality and quantity of rays is not altered by any foreign influences, i.e., the beam of rays must, by adapting the diaphragms, be kept sufficiently parallel and very fine and protected against an exterior undesirable radiation.

In order to diminish as far as possible any measuring faults by scattering rays it is advisable to place the absorbing body in the middle of the *x*-rays' path. Furthermore the same must be so thick that the intensity of radiation, measured once with and once without absorbing medium, gives us differences sufficiently great; this applies especially in the case of water, of which the absorption coefficient is comparatively small.

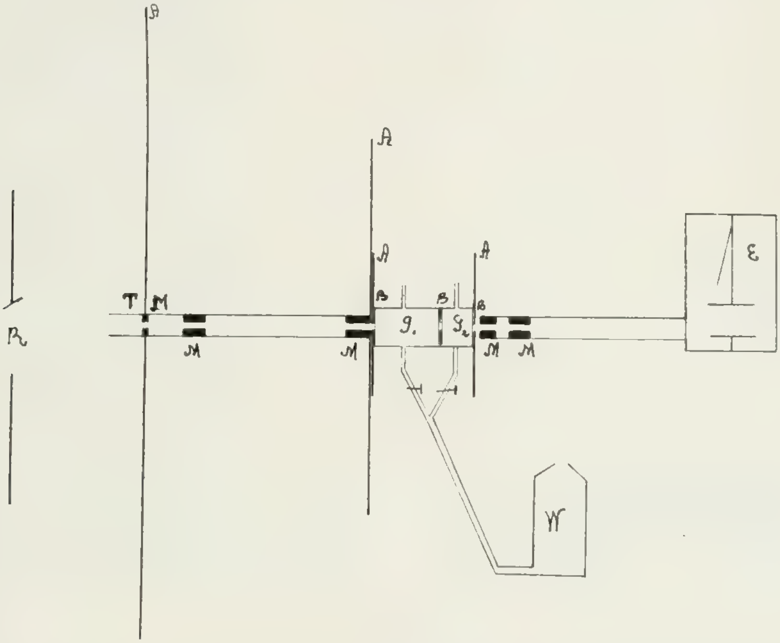


Fig. 1.

In case measuring should be done according to the ionization method, the chamber must be rather large, because if too small a chamber is used, one cannot make sure whether it really works in proportion to the intensity or not.

For the experiments an AEG Coolidge tube with tungsten anticathode was used, fed by a transformer apparatus, and with the spiral heated by a battery of accumulators. This apparatus allows us the use of voltages higher than 200 kv. and of a tube current more than 4 ma., without altering the tension at the tube. The primary voltage could be kept by ohm resistance on a point of .1 volt constantly, which means a secondary one of about 200 volts. The tube current could be kept on .02 ma. constantly.

A lead wall 4 mm. thick (A, Fig. 1) perforated at the level of the anticathode is put in front of the tube R at a distance of 22 cm. from the focus. On the side looking to the tube is a small lead tube T, supplied with a lead diaphragm, receiving the main filters (Cu. and Al.) used for making homogeneous the *x*-rays. On the other side of the lead wall A is a lead tube 3 cm. in diameter, 4 mm. thick and 30 cm. in length, which has diaphragms M on its ends and one inside as well. The first of these consists of a 2-mm., the other two of 2-cm. pieces of brass. On the other end of this tube there is placed another lead wall 4 mm. in thickness, behind which stands the water basin G_1 and G_2. Behind the water basin is the electroscope[1] collimator, 30 cm. in length, with 2 diaphragms M, each consisting of a 2-cm. piece of brass. Each of the diaphrams has a 1-cm. hole

---

[1] Winawer. Back's electroscpe, constructed by the Voifa-Werke.

The water basin is built according to the instructions of Glocker.[1] It is composed of two brass tubes, 4 cm. in diameter, 5 cm. and 10 cm. in length, respectively, which are kept together by a piece of brass tube. The ends of the tubes are closed by glass plates of 1 cm. thickness. Besides these, there are 3 lead diaphragms, B, 4 mm. thick, each with a 1-cm. hole. By raising and lowering the water jug W one or the other or both the tubes can be filled with water.

The measurement itself takes place as follows: Tension and tube current are established at a certain value and the tube put in action for half an hour, because the tube current is constant only after this period of time. Afterwards the intensities are measured with and without the measuring body by the falling time of the electroscope filament. To control the constancy of the intensity, it is measured for each layer thickness first without, then with, and afterwards again without, the measuring body.

The said arrangement allows the falling time to be determined within ±.2 sec.

Fig. 2.

Unwanted rays are examined by closing the tube T with piece of lead of 1 cm. thickness, in which case the electroscope filament did not fall down visibly in a period of 600 sec., with a voltage between 150 and 200 kv. and with a 3 ma. tube current in use.

In order to make homogeneous the radiation, filters of copper and aluminum are used, the thickness of which is varied, until the same absorption coefficient is found with every tension used for 5, 10 and 15 cm. of water.

To determine the quality of the radiation and also the absorption coefficient of a practical homogeneous radiation, one wants the exact knowledge of the limiting wavelength. Therefore one must establish as exactly as possible the maximum voltage at the tube. As a matter of fact, the measurement of it by sparking distance, as it is often executed, only gives us an idea of the maximum voltage. The spectrographic method was taken, even against the common opinion that if high voltages are used, the limit of the short waves does not come out clear, and that therefore it becomes very difficult to fix the voltage by the equation of Planck-Einstein. The spectrometers were built following the system of Seemann.[1] There were three of them in use. The one containing the best crystal was used in the final measurements. Twenty-two spectrograms, between 150 and 220 kv. were made, whereby the tube current and voltage were carefully kept on the same point. To be independent of the network fluctuations, these spectrograms were taken during the night, part of them before starting, part in the middle and the rest at the end of the work. The two last series were photometered by the registering photometer of P. P. Koch[2] for control. The result was a number of spectrograms showing a limit sufficiently clear. Figure 2 shows one of the registered

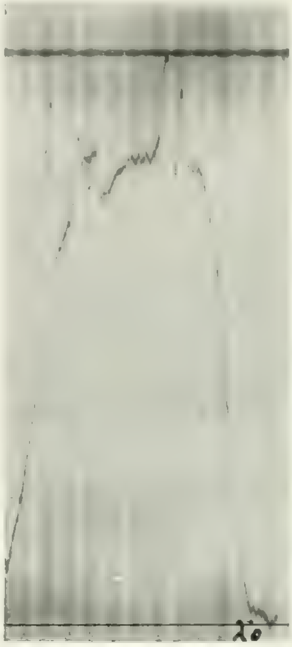


Fig. 3.

---

[1] Glocker, Rothacker und Schönleber. *Strahlentherapie*, 1922, xiv, 393, Figure 2.

[1] Seemann, H. *Phys. Ztschr.*, 1917, xviii, 242; and 1920, li, 1919.

[2] Koch, P. P. *Ann. d. Phys. u. Chem.*, 1912, xxxix, 705.

curves and Figure 3 the spectrogram belonging to it.

The values found for the limiting wavelength λ_0 and the tensions belonging to them are to be seen in Table I.

TABLE I

Primary Voltage at the Transformer (Relative Values)	λ_0 in Å.U.	Secondary Voltage in Kv.	
37	.071	173	first series
42	.062	199	
33	.083 (8)	147.5	second series
33	.084	147.7	
35	.077	160.5	
38	.069	179.0	
40	.064 (8)	191.0	
40	.065	190.5	
42	.061	202.0	
42	.060	203.6	
44	.058	212.0	
46	.056	220.0	
33	.0813	151.7	third series
33	.0811	152.1	
33	.0809	152.5	
35	.0763	161.7	
35	.0760	162.3	
35	.0758	162.9	
39	.0688	179.4	
39	.0687	179.6	
42	.0613	201.3	
42	.0608	202.9	

The greatest error of all the measurements is ±1.5 per cent. We used only the values of the third series. For, taken with the very best spectrometer, they show the most exact limit and the minimal differences between. Here the greatest error is ±.5 per cent.

Table II gives the voltages used for the measurements of the absorption coefficient.

TABLE II

Primary Voltage at the Transformer (Relative Values)	λ_0 in Å.U.	Secondary Voltage in Kv.
33	.081	152.1
35	.076	162.3
39	.069	179.5
42	.061	202.1

For each of these four tensions a great many measurements of the absorption coefficient in water by a layer thickness of 5, 10 and 15 cm. were taken, the results of which are contained in Table III.

TABLE III

Secondary Voltages in Kv.	Tube Current in Ma.	Filters	μ Water 5 Cm.	μ Water 10 Cm	μ Water 15 Cm.	Mean Value
152.1	2	.5 mm. Cu. +1 mm. Al.	.177	.177	.177	.177
162.3	2	.5 mm. Cu. +1 mm. Al.	.165	.166	....	.166
162.3	2	.8 mm. Cu. +1 mm. Al.	.165	.164	.164	.165
179.5	2	.8 mm. Cu. +1 mm. Al.	.150	.150	.151	.150
202.1	2	1.3 mm. Cu. +1 mm. Al.	.142	.140	.141	.141
202.1	2	1.5 mm. Cu. +1 mm. Al.	.140	.141	.141	.141
202.1	3	1.5 mm. Cu. +1 mm. Al.	.141	.141	....	.141

Every single value for 5, 10 and 15 cm. of water in this table is the mean value of a great number of measurements of which the greatest error is ±15 per cent.[1] The greatest error of the measurements of voltages, being .5 per cent lies within the error of the absorption coefficient's values for water. As these values are the same for the different layer thicknesses inside the error, we can call the filtered radiation a practical homogeneous one, which was moreover controlled by varying the layer thickness.

Tap water was used for the measurements, therefore the values of the absorption coefficient might have been falsified by dissolved minerals. But a measurement for which distilled water was taken gives the same result.

In order to determine the absorption coefficient for aluminum and to know which layer of aluminum corresponds with 1 cm. of water, we had to proceed in the following manner:

The layer thickness of aluminum was varied, until, the general conditions being unaltered, the same values were found as for the absorption coefficient of 5 and 10 cm. of water. To make sure whether the values of the absorption coefficient in aluminum might be falsified by impurities, chiefly iron, we had to analyze the aluminum chemically: there was no iron found at all. The results of the absorption coefficient of aluminum are contained in Table IV.

---

[1] The error of every μ-measurement is found in the following equation: $\left(\frac{\Delta t_1}{t_1} + \frac{\Delta t_2}{t_2}\right) \cdot \frac{1}{d \log e} = \Delta\mu$.

TABLE IV

Secondary Voltages in Kv.	Tube Current in Ma.	Filters Thickness in Mm.	μ Water	μ Aluminum	Corresponding Layer of Aluminum	
					for 5 Cm. of Water, Cm.	for 10 Cm. of Water, Cm.
152.1	2	.5 Cu. +1 Al.	.177	.507	1.75	3.5
162.3	2	.5 Cu. +1 Al.	.166	.474	1.73	3.5
179.5	2	.8 Cu. +1 Al.	.150	.429	1.76	3.5
202.1	2	1.3 Cu. +1 Al.	.141	.403	1.75	3.5

In comparing the values found by earlier measurements with ours (Table V) we can see that the values of the absorption coefficient in water correspond well; while in aluminum, they diverge.

TABLE V

Secondary Voltages		Filters Thickness in Mm.	μ Water		μ Aluminum		μ Aluminum Ordinary Arrangement of Test
With Dessauer	With Us		With Dessauer and Vierheller[1]	With Us	With Dessauer[2]	With Us	
150	152.1	.5 Cu. +1 Al.	.180	.177	.77	.507	.62
162.5	162.3	.5 Cu. +1 Al.	.166	.166	.67	.474	.59
181.5	179.5	.8 Cu. +1 Al.	.149	.150	.49	.429	.49
200	202.1	1.3 Cu. +1 Al.	.140	.141	.43	.403	.43

[1] Dessauer und Vierheller. Ueber die Zerstreuung von Röntgenstrahlen in Wasser. *Zeitschr. f. physik. u. diätet. Therap.*, Bd. 4, Heft 1.

[2] Dessauer. Grundlagen und Messmethoden. *Arch. f. Gynae.* Bd. 111, Heft 2, p. 72, Abb. 7.

It is probable that the higher values of the absorption coefficient of aluminum (Table V, Column 6) were caused by the arrangement of test—i.e., the x-rays were not diaphragmed enough—and that the results might have been falsified by soft scattered rays. Therefore a series of measurements with one ordinary arrangement was made, i.e., without a careful diaphragmization before entering the electroscope collimator. These results show, in comparison with the values in Table V, Column 6, a better correspondence.

Perhaps we can explain the difference between our values and those of Table V, Column 6 with softer scattered rays, which are wholly absorbed in the first layers of the measuring body. If we do not sufficiently limit the beam of rays by diaphragms, we will very likely according to the grade of diaphragmization, find the most variable values, whereby we take our values as the lower limit, supposing of course that the x-ray bundle is sufficiently diaphragmed after passing the measuring body. Otherwise the absorption coefficient becomes smaller by softer scattered rays leaving the measuring body. By higher tensions the difference between the former measurements and ours becomes smaller. This means that the soft scattered rays are no more essentially contained in the mixture, owing to the displacement of energy—maximum of rays into the direction of shorter waves.

The value founded by Glasser[1] for water at 200 kv. differs about 30 per cent from ours. As we suppose that in these measurements the diaphragmization was carefully made, the cause of these differences probably lies in other reasons: (1) The filters used (.75 Cu + 1 Al.), which does not give us a sufficiently homogeneous radiation for our rays' beam. (2) The different intensity distribution in the spectrum of the rays sent by the anticathode; at the same shortest wave-length the apparatus can give more softer components. The cause of the differences in output of different apparatus lies in the tension curve, in the phase between cur-

[1] Glasser, l.c.

rent and tension in secondary circuit and, if the filament is heated by alternating current, with a thin filament in the phase between the heating current and the tension at the tube. Therefore we must characterize the radiation used for deep therapy purposes not only by the shortest wave-length *or* the absorption coefficient alone, *but absolutely by both*. This is the only way to be sure that the filtered rays really contain a small part of a spectrum. Every increase of the absorption coefficient with the same tension means that there are still softer components in the mixture used. This shows in our case Figures 4 and 5, which represent spectrograms of the filtered and unfiltered radiation.

Out of the above measurements follows:

Let us extrapolate by using the formula of Richtmeyer and Kerr Grant[1] for the mass absorption coefficient of aluminum $\left(\frac{\mu}{\varsigma}\right)_{AL}$ for our limiting wave-lengths.

Formula: $\left(\frac{\mu}{\varsigma}\right)_{AL} = 14.45\lambda^3 + .15.$

This formula is proved by Richtmeyer up to a wave-length of .08 Å.U., that is our longest limiting wave-length. Table VI gives the values of $\left(\frac{\mu}{\varsigma}\right)_{AL}$ found by our measurements and calculated by the above-mentioned formula for corresponding limiting wave-lengths λ_0.

TABLE VI

λ_0 in Å.U.	$\left(\frac{\mu}{\varsigma}\right)_{AL}$ Calculated	$\left(\frac{\mu}{\varsigma}\right)_{AL}$ Measured	λ Effective
.081	.158	.187	.136
.076	.156	.175	.120
.069	.155	.159	.085
.061	.153	.149	.061

The fourth column of Table VI contains the effective wave-length calculated following Richtmeyer for $\left(\frac{\mu}{\varsigma}\right)_{AL}$ measured. From the second column, containing the mass absorption coefficient of aluminum *calculated*, one can see that the pure absorption is very small for the limiting wave-length measured. But a more important rôle, the pure absorption, takes place in the mass absorption coefficients *measured*, owing to the softer components, which take part in the practical homogeneous x-rays' beam together with the limiting wave-length. The striking result, that the observed mass absorption coefficient of aluminum corresponding to the shortest limiting wave-length is smaller than the calculated one, shows that the mass scattering coefficient for aluminum used by Richtmeyer is too great for this wave-length. That is because in order to get the mass scattering coefficient for aluminum the measured value of .149 must be diminished by any small factor of the pure mass absorption coefficient given by the softer components of the filtered radiation. From this we gather that this mixture of rays contains only a small part of a spectrum and that the pure absorption is no more important. All this concerns in a certain meaning, also, the values for the longer limiting wave-lengths.

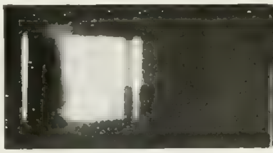


FIG. 4. Unfiltered .75 Cu. + 1 Al.

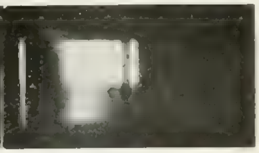


FIG. 5. Unfiltered 1.3 Cu. + 1 Al.

With hard x-rays and the γ rays of radium[1] the mass absorption coefficient of water is nearly evuivalent to that of aluminum. That is because of the minimal pure absorption in both the bodies and the fairly equal scattering.

$$\text{Accordingly} \quad \frac{\left(\frac{\mu}{\varsigma}\right)AL}{\left(\frac{\mu}{\varsigma}\right)H_2O} = 1$$

If we use this relation for our values, we obtain for the four values of limiting wave-length measured the value of 1.06. Therefore, by use of these radiations, the mass absorption coefficient for aluminum is practically equal to water. The same result is given in Table IV, Columns 6 and 7, where the equivalent layer thicknesses of aluminum for 5 and 10 cm. of water are constant for all the four limiting wavelengths. By this follows: $\frac{\mu_{AL}}{\mu_{H_2O}}$ = density of aluminum = 2.7. We found 2.8 for all the four values measured.

---

[1] Richtmeyer and Kerr Grant. *Phys. Rev.*, 1920, xv, 5

[1] Glocker. *Phys. Ztschr.*, 1918, xix, 70.

SUMMARY

Such an arrangement of tests is indicated for the measurements of the absorption coefficient of water and aluminum, as permits one to avoid as far as possible the errors caused by foreign influences.

It is shown that Planck-Einstein's relation gives an exact determination of the maximum voltage at the tube in the measured sphere, presupposing the authenticity of this relation.

We have measured the absorption coefficient for water and aluminum for four tensions and have shown that they are more or less determined by the scattering coefficient.

The value for the mass scattering coefficient for aluminum (.15 used by Richtmeyer) was found too high for $\lambda^0 < .08$ Å.U.

We wish to thank Professor Dr. Dessauer, Direktor des Instituts für physikalische Grundlagen der Medizin der Universität Frankfort, for the stimulus in this work, and Professor Dr. P. P. Koch, Direktor des physikalischen Institutes der Universtität Hamburg, for kindly registering the spectrograms.

THE USE OF ISODOSIS CURVES IN X-RAY THERAPY SHOWING THE INACCURACY OF THE DESSAUER CHARTS

FROM EXPERIMENTS MADE AT THE ROENTGEN DEPARTMENT OF THE HOSPITAL ZUM HEILIGEN GEIST, FRANKFORT (CHIEFS OF DEPARTMENT, DR. FRANZ GROEDEL AND DR. HEINZ LOSSEN)

BY CHARLES GOTTLIEB, M.D.

NEW YORK CITY

MOST of the larger laboratories in this country are using Dessauer's isodosis charts. While attending the recent convention of the German Roentgen Ray Society, I listened to a discussion on the reliability of these charts. There considerable doubt was expressed as to the correctness of the Dessauer measurements.

For these reasons I was especially interested in the results of measurements as presented by Dr. Holfelder at the congress, and determined to make confirmatory tests myself. I am very much indebted to Dr. Holfelder, who placed the records of his very elaborate measurements and carefully prepared results of the same at my disposal. These convinced me of the fact that the intensities within an *x*-ray cone in a water-phantom as obtained on an intensifying screen agree well with the isodosis curves of Dr. Holfelder. I wished, however, to determine through my own experiments, whether the fundamental shape of the isodosis curve remains the same, independent of the apparatus used. Through courtesy of Dr. Groedel I made the experiments in the Roentgen Laboratory of the Heiligen Geist Hospital in Frankfort.

Using the roentgendosimeter of Siemens and Halske, several *x*-ray cones were measured, readings being taken every centimeter, and the results of these measurements agreed accurately with those reported by Dr. Holfelder. It was extremely important to determine the errors due to the finite size of the ionization chamber. Holfelder, after careful consideration, has determined upon a method of correcting his curves in order to eliminate these errors (Fig. 1, center). This correction is determined through measurements of intensity within an air-phantom, in which the ionization chamber is only partially and gradually exposed to the radiation. This is accomplished by covering part of the ionization chamber with a lead plate. I have made it certain by these experiments, that when changing the position of the ionization chamber from a place of high intensity to one of low intensity the indication is blurred to the extent as found by Holfelder. Therefore it seems to me that the corrections made on the curves of intensity, as determined by Holfelder, are well proven, not only with regard to direction, but also as to numerical value. This way we arrive at the final form of the isodosis curve (Fig. 1, right) which differs from the form of the Dessauer curves in a remarkable way. The difference is evident not only at one point, but in all characteristic points, along its entire run. This fundamental form is not influenced by the position of the diaphragm. I have made measurements with different cones of rays, during which the diaphragm was placed as close to the focus of the tube as possible. By doing this the transition at the limit of the cone into the stray field seems to be blurred only to a very slight extent. This can be figured exactly within the limits of the partial shade, which is determined geometrically by the width of the focal point of the target distance of the diaphragm from the focal point and from the water-phantom. I have made tests on several cones duplicating the conditions given by Dessauer for his charts. The measurements were made using the Neointensivreform apparatus which is Dessauer's own design, and which was calibrated by the Dessauer Institution,

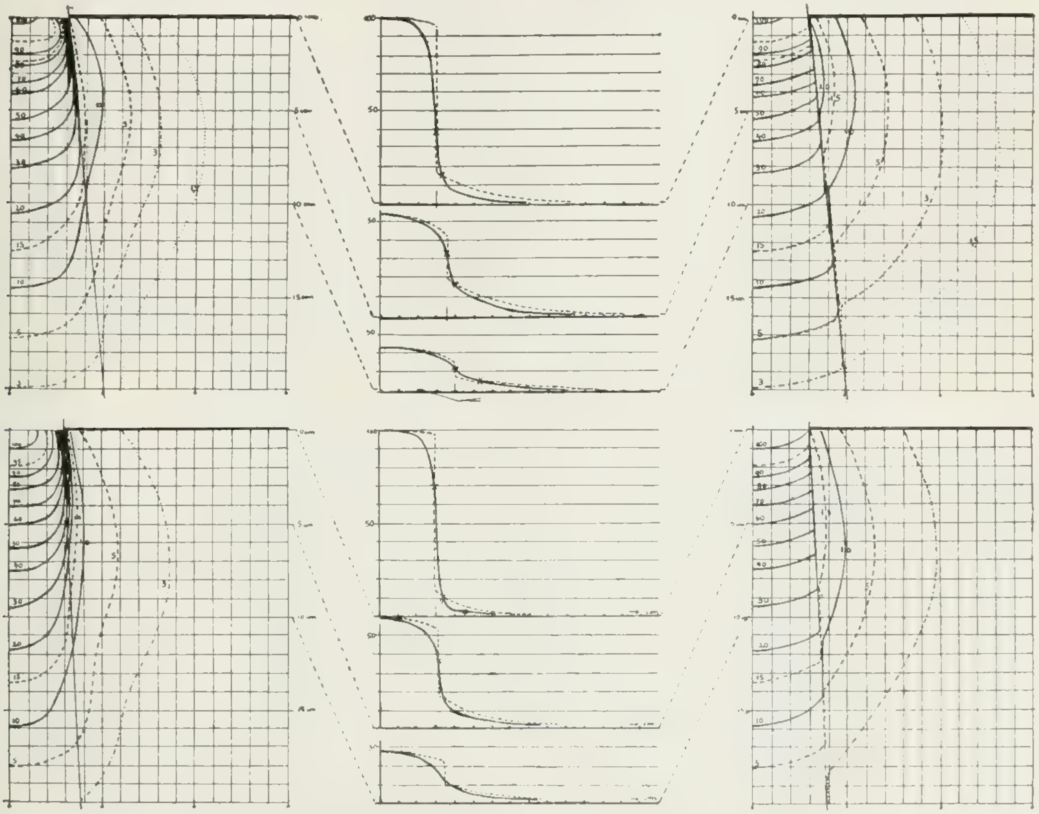


Fig. 1. This shows the development of the isodosis curves according to Holfelder, taken from a paper by Holfelder, Bornhauser and Jaloussis, in the "*Strahlentherapie.*" Two *x*-ray cones are shown, taken with round diaphragms. Diameter of the diaphragm 6 cm. Diaphragm placed on surface of water. Symmetry-apparatus. Fuerstenan-Coolidge-tube. Equivalent spark-gap 45 cm., current 3 ma. Filter 0.5 cm. Cu. Half absorption value layer 13 mm. Al.

Above: *x*-ray cone with a focal distance of 30 cm. Below: *x*-ray cone with a focal distance of 70 cm. Left: direct plotting of measured values shown by curves of isodosis. In the center: plotting of measured values in horizontal planes; on the surface, at a depth of 5 cm. and at a depth of 10 cm., showing curves of intensities in these planes. Correction of these curves in order to eliminate errors due to the ionization chamber. Right: actual isodosis curves of both cones after correcting values of intensities. The sharp limitation of the primary cone and weakness of the stray-field are very apparent.

This chart is one-quarter original size, each square representing one square centimeter.

so that the values of crest (max.) voltage correspond to those of Dessauer. The results of these measurements were totally different from those of Dessauer, but agreed well with the Holfelder curves. The values of the differences must therefore be shown in an example.

The following table shows the measured intensities within an *x*-ray cone as per cents of the intensity at the surface. The figures in parenthesis are the intensities as given by Dessauer for the same conditions. The apparatus used were Neointensivreform apparatus, Fuerstenan Coolidge tube with tungsten target, transformer voltage 200 kv. (max.), current 2 ma., filter 1.3 mm. Cu. and 1 mm. Al. Focal distance from surface 30 cm., diaphragm in the center between focal point and surface. Area of field 5.7 × 7.6 cm., $\mu = 0.140$ (for water).

Depth, Cm.	Center Ray	2 Cm. Lateral from Center	4 Cm. Lateral from Center	6 Cm. Lateral from Center
0	100 (100)	98 (94)	12 (57)	5 (27)
2	95 (79)	90 (76)	17 (51)	9 (27)
4	75 (65)	70 (62)	23 (45)	11 (26)
6	54 (55)	51 (52)	24 (38)	12 (25)
8	39 (46)	37 (44)	20 (34)	11 (23)
10	28 (39)	27 (37)	15 (29)	9 (20)
12	20 (33)	19 (31)	12 (25)	6 (16)
14	14 (26)	14 (24)	9 (21)	4 (13)
16	9 (22)	9 (21)	5 (15)	3 (13)

Fig. 2. This is a reproduction of a film made by me, at one-third original size. The film shows the longitudinal section through a round *x*-ray cone, taken under the same conditions as given below Figure 1. Notice the primary cone, sharply defined to a considerable depth, and the weak stray-field around the same. This film agrees perfectly with the isodosis curves of Holfelder obtained under the same conditions.

I hesitated to believe that an *x*-ray physicist as prominent as Prof. Dessauer should make such fundamental errors, and wished to assume that the differences are due to some special behavior of the Siemens dosimeter. Therefore I looked for another method, different from that of Holfelder, in order to get the results, and investigated several *x*-ray cones in water-phantoms using a photographic film for measuring the relative intensities. The films were developed immediately after exposure. Reduced size reproductions of these films are shown in Figures 2, 3 and 4.

Figure 2 shows a narrow cone of *x*-ray, having a width of 6 cm. at a focal distance of 70 cm., using the same quality of radiation as for making the measurements. The diaphragm was close to the surface of the water in this case. One can clearly see the rather deep sharply defined cone and the weak pear-shaped stray field around the same. Figure 2 shows the same proportion with a field of 12 cm. in width and having a focal depth of 50 cm. Here we have also found a complete agreement with the iontoquantimetric results. Figure 3 shows a narrow cone having a focal distance of 80 cm., where the diaphragm was placed in the center between the surface of water and the focal point. Here the film was placed slightly at a slant to the center ray, so that there seems to be a convergence of the rays toward the depth, which, however, shows only the oblique section of the cone. In this case too, we can see a perfect agreement with the measurements, and the fundamental form is the same as in the other pictures, except that the edges seem to be slightly blurred, due to the effect of a partial shadow. When making exposures on films placed perpendicular to the center ray in the water-phantom, I received sharply defined, almost homogeneous records of the *x*-ray cone at considerable depths. This proved to me that the silver emulsion responds not only

FIG. 3. A wider cone shows the same form of distribution of intensities. The stray-field is only slightly stronger than that of a narrower cone. This film was taken with a focal distance of 50 cm. and a diaphragm of 12 cm. diameter. The conditions of tests were the same as before. This shows, too, the exact agreement with the Holfelder curves, and the strong difference from Dessauer's forms. Reduction one-third original size.

to rays of a certain direction, but is giving a true record of the intensity curve at any place in the water-phantom. After measuring the blackening of the films photometrically, at different points, we have plotted curves of iso-blackening, which are in complete agreement with the isodosis curves of Holfelder.

These different experiments conclusively prove the Dessauer charts to be fundamentally incorrect and rather unsafe for practical use. They also demonstrate that the isodosis curves of Holfelder agree well with actual conditions. The forms of the Holfelder curves differ so greatly from those of Dessauer that it appears very important to point out the most salient differences.

1. According to Dessauer, the main, primary cone is surrounded with a very wide and only slightly weaker stray-field. The primary cone, according to the Holfelder experiments, is sharply defined, and shows, even with the diaphragm placed at a considerable distance from the surface of the water, only a very narrow transitory field, which can be well explained to be due to a partial shadow. The stray field around the primary cone is of an extremely small intensity when compared to the intensity of the primary cone. This is so marked that the neglecting of the stray-field in practical use can never cause *x*-ray burns, neither can the stray-field be used for therapeutic purposes, as stated by Dessauer and his followers.

Fig. 4. Not even the position of the diaphragm changes the form of the distribution of intensity. The limit of the cone only seems to be slightly blurred. The film was taken under conditions similar to those given by Dessauer. The film was placed in the water-phantom at a slight slant, which accounts for the converging of the limits of the cone, according to the shape of a cone section. This is further proof of the fact that the primary cone is sharply limited even when the diaphragm is placed at a distance from the surface. The focal distance was 80 cm., and the diaphgram used had an opening of 3 cm. diameter, and was placed at the center between the surface of the water and the focal point of the tube.

2. The Dessauer curves show a divergence below the surface. The stray-fields of the Holfelder curves show a contraction at the surface, and a second very clear contraction at larger depths of the phantom.

3. The per cent intensity values at depths appear, according to Dessauer's data, to be too high. It was impossible to reach such values when making the tests, even with the highest available voltage. Since Dessauer made his experiments with apparatus of older types, it seems improbable that he would have had any harder rays at his disposal than the ones we used in our experiments.

4. The change of intensity toward depth follows in the Dessauer curves approximately the shape of a logarithmic curve; while the Holfelder curves and also my tests have in every case shown a very prominent hump at the beginning of the curve.

The conclusions drawn from these considerations seem to justify the title of this article.

ADVANCES MADE IN THE ROENTGEN-RAY STUDY OF GALL-BLADDER DISEASE

BY DORWIN PALMER, M.D.

PORTLAND, OREGON

THE progress which has been made in roentgen-ray interpretation, technique and apparatus has given to the medical profession an excellent instrument for the study of those cases in which infection of the gall-bladder is suspected. In the past the clinician placed little confidence in the roentgenologist's opinion regarding the gall-bladder. This was probably due to the inefficiency of the equipment and to the lack of interest shown. Previous to 1911, our attention was directed largely to the study of the gastrointestinal tract. It was while proving out the various procedures in these studies that the fundamental principles were ascertained for detecting the shadow of the gall-bladder. From this period there has been a gradual development due to the persistent efforts of the pioneer roentgenologists, Cole, Caldwell, George and Leonard, for they impressed upon us the necessity of carefully observing the salient points in technique. An article was published in 1916 by Cole and George, outlining the essential principles in examination of the gall-bladder. With minor changes we are able today to obtain from their work the maximum of soft-tissue detail. It was thought then that the detection of gall-stones was the goal to be attained. George of Boston first called our attention to the fact that the pathological gall-bladder may be shown more often than the calculi. He also stated: "Only when pathological change has taken place in the walls of the gall-bladder or in its contents can the shadows be demonstrated on the *x*-ray plates." From our experience, this statement may be questioned. These shadows are at times difficult to demonstrate; therefore, the roentgenologist should have the hearty cooperation of the clinician and the patient, and must be permitted to employ the time necessary to complete the study satisfactorily.

The preparation of the patient is of first importance. The colon should be thoroughly emptied and freed of gas which is invariably present, due to disturbed motor and possibly secretory functions. This condition is accentuated by the use of cathartics. Our routine has been to use enemata of hot soapsuds at four in the afternoon and again at bedtime on the day preceding the examination, and this is repeated upon arising the following morning. Detailed instructions should be given as to the temperature and quantity of the water, the manner in which the solution should be taken and the length of time it is to be retained. For twelve hours preceding the examination food should not be given.

Before making the films, the patient must be impressed with the importance of holding his breath and of complete muscular relaxation. The slightest movement of the diaphragm or other muscles of respiration will obliterate all soft-tissue detail and blur the delicate ring shadows of gall-stones when present.

The roentgen-ray findings in gall-bladder disease may be classified under three headings: Direct, Indirect and Eliminative.

Direct Evidence. By this is meant the demonstration of the gall-bladder or biliary calculi on the film. Properly taken, the films include the entire area from the twelfth rib to the pelvis, and will show a clear-cut outline of the right kidney and the margin of the liver. Shadows cast by gall-stones may be confused with renal calculi, calcified lymph-nodes, suprarenal glands or enteroliths in the tip of a long, retrocecal appendix. A corset lobe of the liver and a dilated duodenum may be mistaken for the shadow of the gall-bladder itself. The gall-bladder shadow is, as a rule, sharply contrasted, with well-defined borders; especially is this true of the inner border. To differentiate the gall-bladder shadow from a corset-lobed liver or dilated duodenum often requires the correlation of the gastrointestinal report. Gall-stones are commonly identified by their typical ring-like appearance, yet many are seen which do not present this characteristic and therefore require more care in the differential study.

Indirect Evidence. This is the term applied to the changes in contour of neighboring viscera resulting from pressure or from a localized peritonitis. These changes are noted in the gastric antrum, bulb, duodenum and hepatic flexure of the colon. The antrum is always the seat of spasm, and may exhibit constant filling defects as a sequel of pericholecystitis. The duodenal bulb is flattened and occasionally so deformed that an ulcer would be suspected. The association of gastric or duodenal ulcer with chronic gall-bladder disease is not infrequent. The duodenum and hepatic flexure of the colon are frequently involved in the process and show resulting irregularities and distortions of normal contour. It should be remembered that these changes may be observed in other conditions. They are, however, very suggestive and should cause a diligent search to be made for direct evidence of cholecystitis.

Here it would seem proper to speak of the so-called "Harris membrane," described by Cole at a recent meeting of the American Roentgen Ray Society. This thin, veil-like structure passes from the lesser omentum over the antrum, cap and duodenum to the under surface of the liver and is evidenced by a blurring of the lesser curvature margin of the antrum or bulb. The etiology of the structure is by no means established. It is at times present where there is unimpeachable evidence of gall-bladder infection; and again, it is an incidental finding of the surgeon during the routine abdominal exploration.

Eliminative Evidence. This is equally as important as the positive indirect findings, since the presence of a normal gastrointestinal tract (if we may use the term) almost rules out the possibility of cholecystitis.

The diagnosis of gall-bladder disease is not limited to the demonstration of gall-stomes on the films, but is made on the basis of the correlation of direct and indirect evidence. Positive cases must show, as a rule, direct evidence and, to some degree, distortion of neighboring viscera. If there are but one or two indirect points, we can do no more than suggest the possibility of gall-bladder disease and reexamine the patient at some future time. It is well to remember that the preparation of the patient and the exposure of the films is relatively a simple procedure, and failure is the result of the lack of attention to some seemingly unimportant detail.

We find in our records that, during the twelve months from October 1, 1921, to October 1, 1922, we have passed an opinion in 330 cases on either the positive or negative aspect of the gall-bladder. One hundred and thirty-one have presented direct evidence of gall-bladder infection; 28 showed stones, and 103 the shadow of the diseased viscus. All cases in the group with ten exceptions, 7.6 per cent, have shown some distortion of neighboring viscera. Fifty-three of the above cases have been submitted to surgery; cholecystectomy was done in 50, the pathological reports confirming in each the roentgen-ray findings. The remaining 3 were said to exhibit no gross evidence of pathology. In the total cases examined, 135 gave no direct evidence of gall-bladder disease; of this number 16 have been operated upon; 1 which was reported negative showed a definite cholecystitis. A positive roentgen-ray report was rendered in 3 cases having negative gall-bladder films, because of the presence of indirect evidence. The operative findings were negative. The distortion was due to ulcer. The error here was 22.2 per cent. This gross error was due to the fact that the *x*-ray opinion was rendered wholly on indirect evidence, and it is in these cases that George[4] warns us against placing too much credence upon findings in and about the duodenum without confirmation of gall-bladder films. Forty-five cases were classified as suspicious. In these cases the films exhibited about the gall-bladder increased densities which could not be positively identified. Many showed more or less positive indirect evidence, which, together with clinical data, resulted in 12 being submitted to operation. The roentgen-ray evidence was shown to be correct in 11; 1 patient revealed no pathology of the gall-bladder. The patient referred to was screened within the past week and there still remains some doubt whether even after exploration, a true gall-bladder disease may not exist. This brings up a question which was discussed before the San Francisco City and County Medical Society, in September of this year, namely: "Are we able to state definitely by gross examination that a gall-bladder is not infected?"

Cases studied from October 1, 1921, to October, 1922:

Total positive or negative opinions	330
Operative findings reported on	81
Correct interpretations	73
Errors	8
Percentage correct	90.2
Percentage error	9.8
Percentage of gall-stones in positive cases	21.4

In conclusion we may say that the presence of direct and indirect findings is sufficient to establish the diagnosis of gall-bladder disease in at least 90 per cent of the cases, which is far in advance of our previous results.

BIBLIOGRAPHY

1. Case, James T. *J. Am. M. Assn.*, Sept. 20, 1913, lxi, No. 12, p. 920. Am. J. Roentgenol., iii, No. 5, p. 246.
2. Cole, L. G. *Surg., Gynec. & Obst.*, Feb., 1914, xviii, 218. Am. J. Roentgenol., Feb., 1915, ii, No. 2, p. 645.
   Cole, L. G., and George, A. W. *Boston M. & S. J.*, Mar. 4, 1915, clxxii, No. 9, p. 326.
3. George, A. W., and Gerber, I. *Boston M. & S. J.*, 1914, clxx, 680.
4. George, A. W., and Leonard, R. D. Am. J. Roentgenol., July, 1917, iv, No. 7, p. 321.
   The Pathological Gall-Bladder. Hoeber, New York, 1922.
5. Pfahler, G. E. *J. Am. M. Assn.*, Apr. 25, 1914, lxii, No. 17, p. 1304.
6. Roberts, Dudley, *J. Am. M. Assn.*, Dec. 4, 1920, lxxv, No. 23, p. 1534.

DIVERTICULUM FROM THE ANTERIOR SURFACE OF THE STOMACH NEAR THE CARDIO-ESOPHAGEAL JUNCTION

BY LEONARD J. RAVENEL, M.D.

Roentgenologist, The Saunders Memorial Hospital

FLORENCE, SOUTH CAROLINA

THIS patient applied for *x*-ray examination on account of burning sensations in the upper gastric region with regurgitation of large quantities of mucus. Symptoms of indigestion had continued over a period of many years, during which time the appendix had been removed and the gall-bladder explored on separate occasions. The patient was a female, sixty-five years of age, and in a much enfeebled condition. *X*-ray examination showed two distinct pouches projecting from the anterior wall of the stomach at the cardiac end. These can be very clearly made out, especially in the oblique projection. The condition of the patient was such as not to permit of operative procedure.

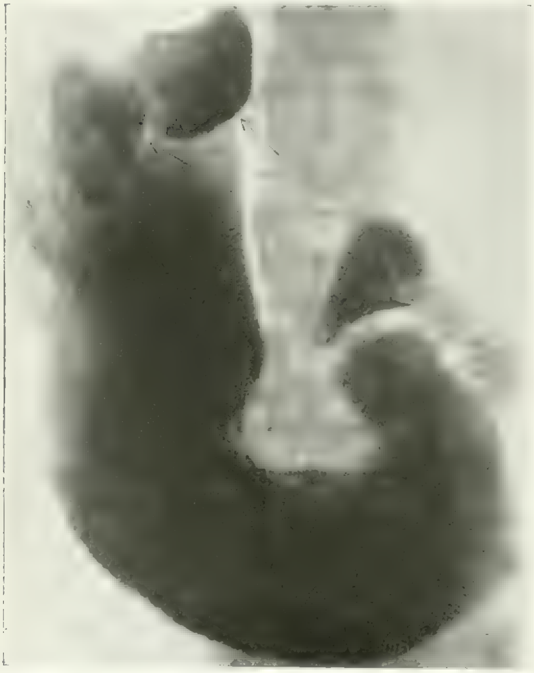


FIG. 1. Immediately following barium meal.

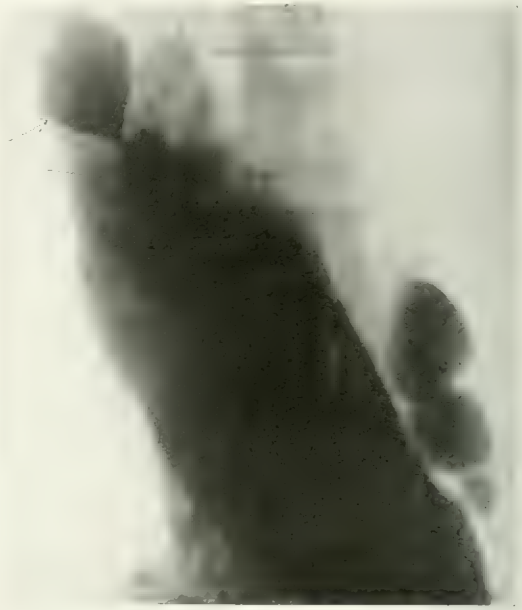


FIG. 2. Oblique view, immediately after barium ingestion.

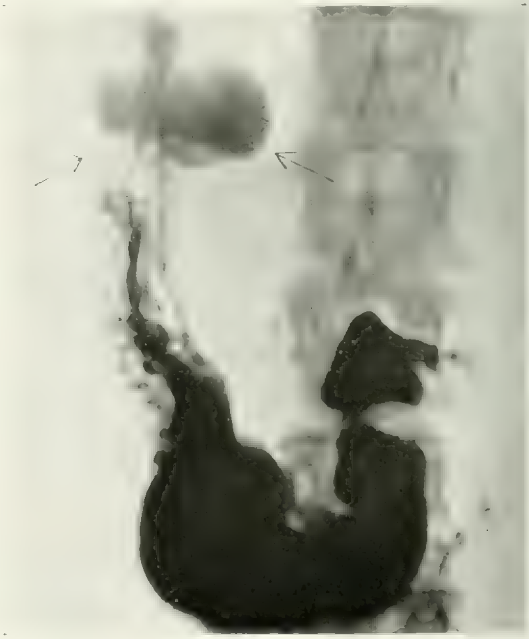


FIG. 3. Four hours after barium ingestion.

RAPIDLY DEVELOPING COMPLETE PYLORIC STENOSIS: REPORT OF A CASE

BY HAROLD SWANBERG, B.SC., M.D.

QUINCY, ILLINOIS

THE following case of complete pyloric stenosis developed so rapidly, and the clinical symptoms were so indefinite, that it was thought worthy of reporting.

REPORT OF CASE

Male, aged sixty-five, a retired physician, was referred to me by Dr. Warren F. Pearce on May 15, 1922, for roentgen examination of the stomach, the clinical diagnosis being undetermined.

The patient's past history was of little interest except that about eight years ago he was operated upon for gall-stones, and a very large stone was removed. He had always had a good appetite and had partaken of alcoholics only in moderation. His present illness dated back about five weeks, when he began to complain of gastric distress after meals. Prior to that time he was enjoying the best of health and was able to partake of practically any combination of food. His own words were: "I did not know I had a stomach." This gastric distress was characterized by a sense of fulness after meals which was rapidly becoming more pronounced. No pain was ever complained of and the patient had vomited but once since his illness had begun. There was marked loss of strength and weight. He had lost some 11 lbs. in the previous three weeks. No blood had been passed by mouth or rectum. The patient had been suffering with chronic constipation for some years. An examination of the gastric contents had been made, but unfortunately the report was lost. The findings, however, were not conclusive enough to warrant making any definite diagnosis.

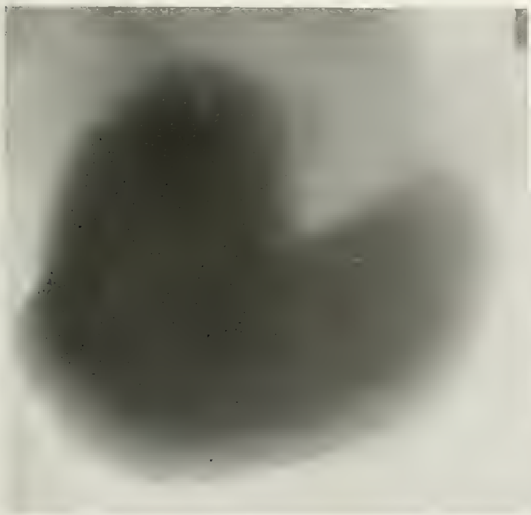


FIG. 1. Roentgenogram of stomach twenty-four hours after barium meal and three-fourths of an hour after administration of $\frac{1}{50}$ grain atropine sulphate hypodermically, showing a complete pyloric stenosis.

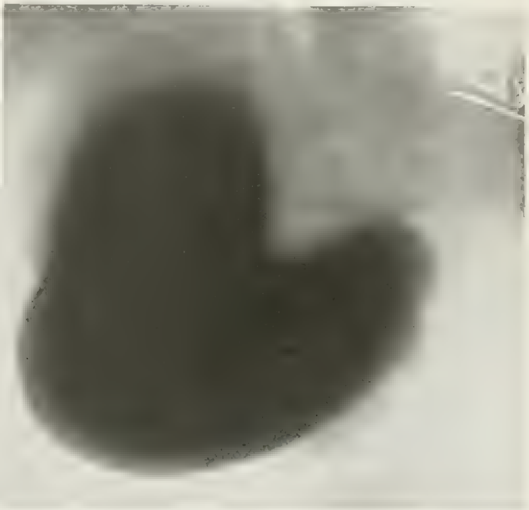


FIG. 2. Same case as in Figure 1. Roentgenogram made forty-eight hours after the barium meal, showing the pyloric stenosis still complete.

The physical examination revealed a fairly well-nourished man. Cataracts were present in both eyes, rendering vision difficult. Abdominal palpation revealed a very large postoperative ventral hernia which followed the old gall-bladder operation. No abnormal masses could be palpated in the abdomen. A fluoroscopic examination of the chest was negative. Other than this the general physical examination was not remarkable. A fluoroscopic and roentgenographic examination was made of the stomach and as a result, I sent the following report to the referring physician:

"The esophagus was negative. The stomach was greatly increased in size, with very weak peristaltic waves. Persistent palpation failed to empty the stomach. No filling defect was in evidence but there was a marked broadening of the duodenopyloric sulcus and there appears little doubt that there is a small growth encircling the pylorus. Observations at six, twenty-four and forty-eight hours showed a complete pyloric stenosis. A reexamination was made after 1/50 gr. of atropine sulphate was given hypodermically, but the pylorus failed to open, and twenty-four hours later the pyloric stenosis was still complete. Conclusion: Pyloric malignancy, resulting in complete pyloric obstruction with marked gastric dilatation. Immediate surgical relief is indicated."

Following the completion of the roentgen examination, the patient immediately left for the Mayo Clinic where he was promptly operated upon. The following personal communication, giving the postoperative findings, was received from Dr. W. J. Mayo:

"Dr. —— was operated on here May 20, when your diagnosis of pyloric malignancy with obstruction was confirmed. A posterior gastro-enterostomy was made at that time. May 26 it was necessary to go in again, when an entero-anastomosis was made. Dr. —— got on very well following this and June 24 I resected the pyloric end of the stomach for removal of the carcinoma. The growth came out very well. Dr. —— has been getting on satisfactorily and will be able to go home in about two weeks."

The patient returned home the latter part of July and showed marked clinical improvement. He continued to improve generally, gaining considerable weight. In November, symptoms appeared indicating a recurrence of the old trouble, which finally caused the patient's death on January 31, 1923.

COMMENTS

This case is interesting in that the duration of the symptoms was so short and the resulting pathology so marked. Further, the clinical symptoms were such that a diagnosis of malignancy was unsuspected, especially a complete pyloric stenosis.

The growth being located in the pyloric ring and rapidly growing, quickly produced a complete pyloric stenosis. The stomach rapidly dilated because of the obstruction. The peculiar clinical feature of the case is the failure of the patient to vomit with such a complete stenosis present.

The case well illustrates the value of the roentgen method in the early diagnosis of gastric malignancy. Carman[1] of the Mayo Clinic says. "In the Mayo Clinic, 95 per cent of gastric cancers have given distinct roentgenologic signs of their presence, a percentage not approached by any other process of examination." Every patient past middle life, with indefinite gastric symptoms that do not respond to the usual medical and dietetic treatment should be regarded as suspicious of malignancy, and a roentgenological study should be advised.

---

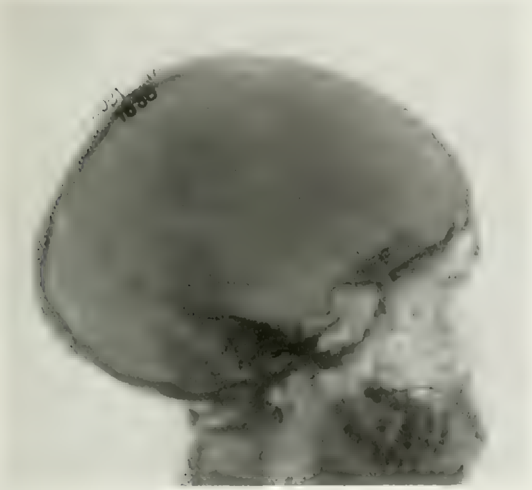
[1] Carman and Miller. The Roentgen Diagnosis of Diseases of the Alimentary Tract. Philadelphia, 1917, p. 171.

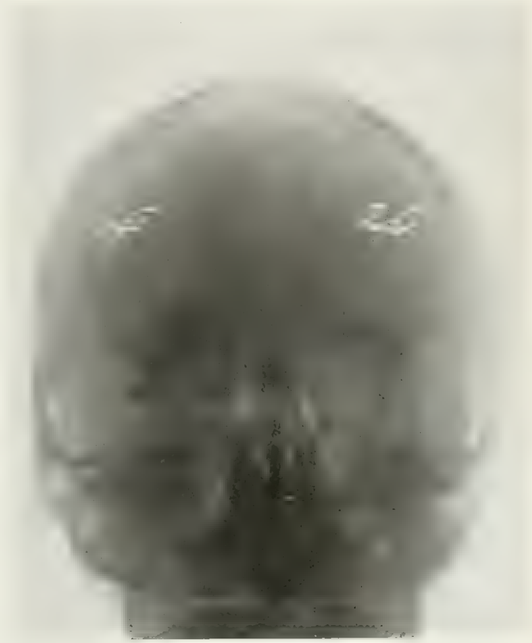
AN UNUSUAL SHADOW IN THE HEAD INTERPRETED AS CALCIFICATION IN THE LEFT LATERAL VENTRICLE

BY A. ROBERT TAFT, M.D.

CHARLESTON, SOUTH CAROLINA

IN February, 1923, a white female twelve years and eleven months old was referred for an *x*-ray examination of the head. There is a definite history of minor epileptic attacks since the winter 1917–1918, when she had an attack of influenza. At first the attacks were quite mild, but later the convulsions increased in severity and frequency. As many as three or four attacks occured in twenty-four hours. These attacks were ushered in by a contraction of the head to the right and a clinching of the right hand.





In September, 1920, a sore appendix was removed. This did not seem to influence the attacks. There was a suspicion of attacks during sleep, but this was not confirmed. Menstruation was ushered in in 1921, but it had no relationship to the convulsions. For the last four months attacks have been much less severe and frequent. Luminal was taken for some time with no apparent effect. The appetite is normal, and the patient sleeps well. Wassermann was negative. Health is apparently good, but the hemoglobin is only 60. Early in March the eyes became inflamed, especially the left, and vision was dull. The ophthalmologist reports an acute uveitis with spots on the cornea, etc. Mercury and potassium iodide were used followed by a decided improvement in vision with a subsidence in inflammation in two months.

X-Ray examination shows a definite shadow of increased density in the left side of the skull. This is more or less triangular in outline and was reported as a calcification of the wall of the left ventricle.

The patient was referred to Dr. Walter E. Dandy, of Baltimore, Md., who confirmed the *x*-ray opinion and thought it was the probable cause of the epilepsy. Operation was refused on account of its relationship to the speech centers.

ERRORS IN THE DIAGNOSIS OF FOREIGN BODIES IN THE AIR PASSAGES

BY PORTER P. VINSON, M.D.

Division of Medicine, Mayo Clinic

ROCHESTER, MINNESOTA

ROENTGENOLOGIC examination is one of the most valuable procedures in the diagnosis of foreign bodies in the air passages, and particularly when the foreign body is of such consistency that it is opaque to the ray. In this group of cases, however, errors may arise in the interpretation of shadows. Three cases, illustrative of this, have recently come under my observation.

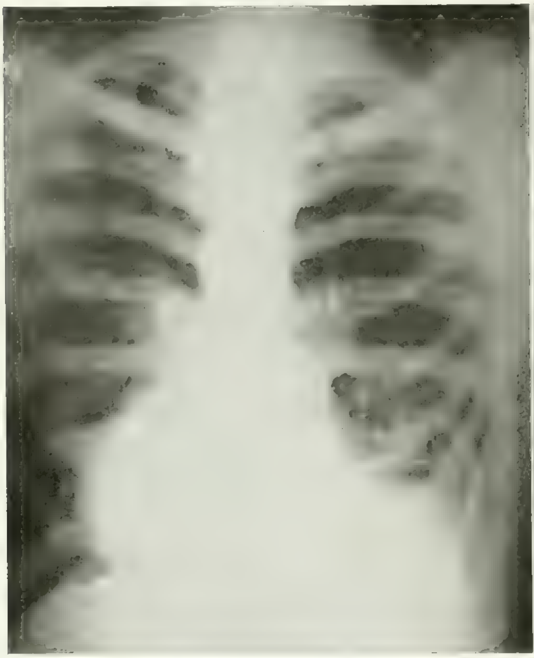


FIG. 1. (Case A424285). Roentgenogram showing a shadow in the right descending bronchus, apparently a collar button.

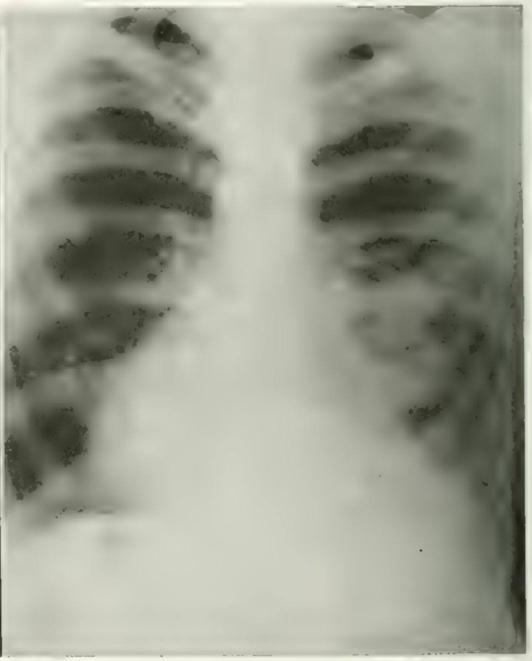


FIG. 2. (Case A424285). Roentgenogram taken after bronchoscopy and dilatation of a bronchial stricture. The shadow, supposed to be a foreign body, has disappeared.

REPORT OF CASES

Case I (A424285). Male, aged twenty-eight years. Came to the Mayo Clinic May 1, 1923. At eight years of age, he had aspirated a collar button of unknown composition. A roentgenographic examination, taken at that time, failed to reveal the foreign body. Six months after the accident, the patient had an attack of pneumonia which lasted for three weeks. This was followed by a cough with a considerable amount of purulent expectoration. Two years after the attack of pneumonia, empyema of the right side developed. Drainage was instituted and the thoracotomy incision healed after about two and a half months. From this time on, the patient continued to have three or four coughing spells each day. About an ounce of sputum, purulent in character, and at times slightly stained with blood, was expectorated at each paroxysm. The general nutrition of the patient was excellent. A roentgenographic examination had been made just before he came to the Clinic, and a diagnosis of a collar button in the right descending bronchus was made (Fig. 1).

Physical examination revealed marked clubbing of the fingers and signs of a chronic bronchiectasis at the base of the right lung. Roentgenographic examination apparently confirmed the findings previously recorded. On May 2, 1923, bronchoscopy was performed under local anesthesia, and a cicatricial stricture without granulation tissue was located in the right descending bronchus. Forceps were introduced through the stricture into the small cavity

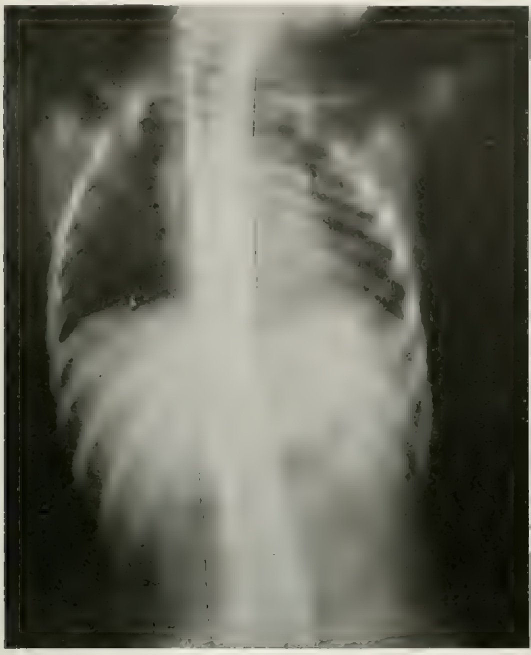


Fig. 3. (Case A428180). Roentgenogram showing a shadow over the left main bronchus. A diagnosis was made of a straight pin in the bronchus.

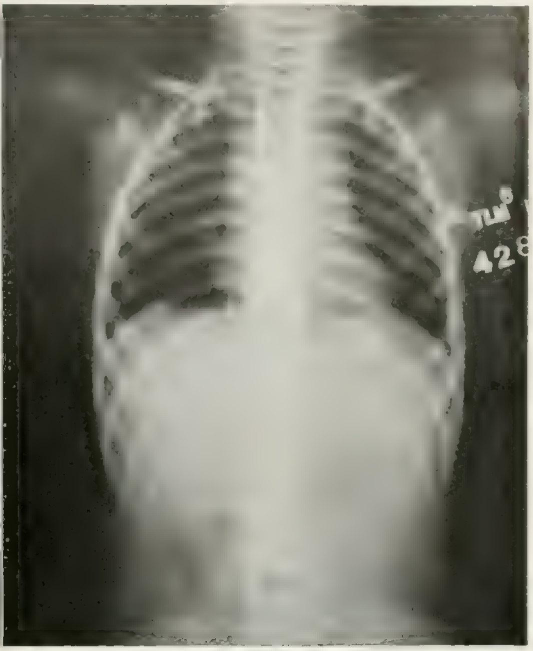


Fig. 4. (Case A428180). Roentgenogram showing no evidence of the pin in the bronchus.

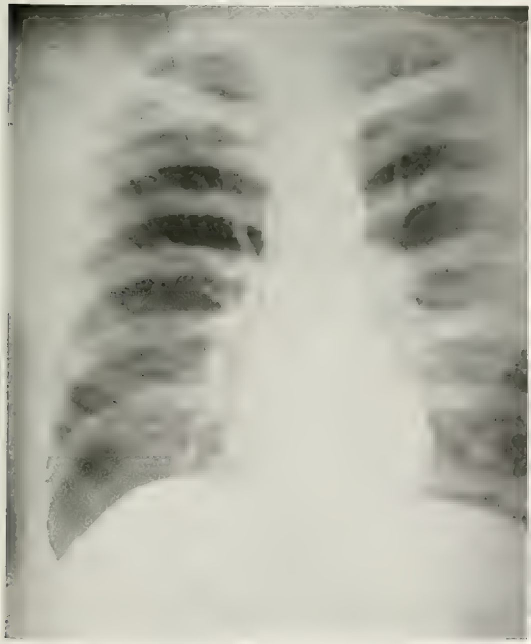


Fig. 5. (Case A430533). Roentgenogram showing a foreign body, fence staple, apparently located in the right main bronchus (Courtesy of Dr. W. A. Rush).

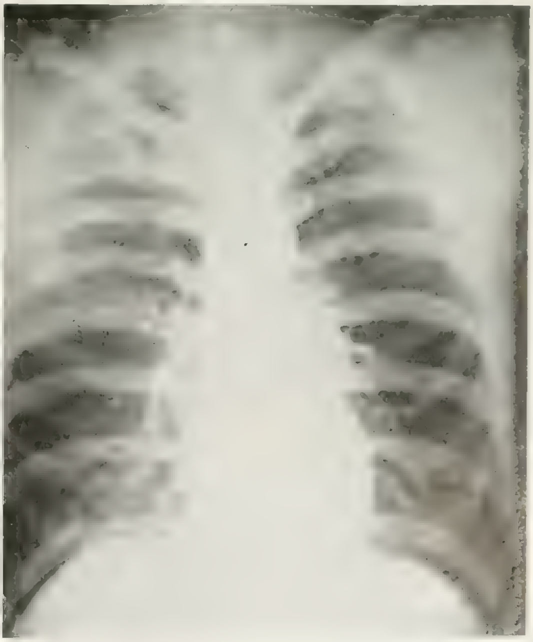


Fig. 6. (Case A430533). Roentgenogram showing no evidence of the foreign body in the bronchus.

below, but the supposed foreign body could not be grasped. The stricture was then forcibly dilated with the forceps, and the examination discontinued. On June 20, 1923, a second bronchoscopy showed that the stricture in the bronchus was of a much wider lumen than at the first examination, but the foreign body could not be located.

Repeated roentgenographic examinations have been made since the stricture in the bronchus was first dilated, but we have been unable to demonstrate the original shadow that appeared to be the collar button (Fig. 2). It is probable that the shadow was a fibrous cast of the button that was broken up by the dilatation of the bronchial stricture. A portion or all of the button may still remain in the small abscess cavity below the stricture, and further attempts to locate it will be made. It is possible, however, that the button may have been of such composition that complete disintegration has taken place.

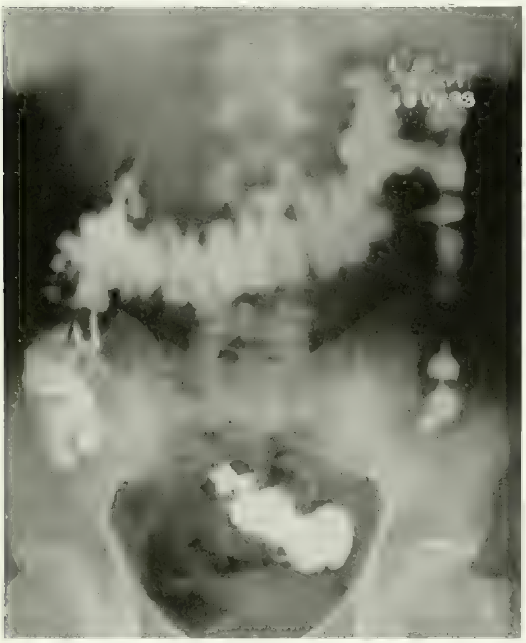


Fig. 7. (Case A430533). Roentgenogram showing fence staple in the ascending colon.

Case II (A428180). Female, two years of age. Brought to the Mayo Clinic, June 6, 1923, because it was believed that she had aspirated a pin one week before. The mother had seen the pin in the baby's mouth, but on her attempt to remove it, the child had strangulated and the pin disappeared. The family physician assumed that the patient had swallowed the foreign body, and instructed the mother to watch the stools. As the pin did not appear in the stools after two or three days had passed, roentgenograms of the chest were taken, and a diagnosis of a pin in the left main bronchus was made (Fig. 3). The patient was then brought to the Clinic for bronchoscopy.

Physical examination of the chest revealed nothing abnormal, and the child was free from pulmonary symptoms. Roentgenographic examination failed to reveal any foreign body (Fig. 4). On further questioning the parents, it was learned that the baby had been covered with a towel at the time of the first roentgenographic examination, and it is probable that the shadow seen in the roentgenogram was from a pin in the towel, or on the examining table. It is a peculiar coincidence that the shadow should have appeared directly over the left main bronchus. The marked movement of the pin in the roentgenogram should have suggested that the foreign body was not located in the thorax.

Case III (A430533). Male, forty-one years of age. Came to the Mayo Clinic June 23, 1923, because he had swallowed a staple four days before, while repairing a fence. A roentgenographic examination of the chest had been made the following day, and the staple was supposedly located in the right main bronchus (Fig. 5). Under the fluoroscope a stomach tube was passed beyond and far to the left of the foreign body. It was, therefore, assumed that the staple was not in the esophagus. There had been no pulmonary symptoms at any time.

By roentgenographic examination at the Clinic, the staple could not be demonstrated in the thoracic cavity, but was located in the ascending colon (Figs. 6 and 7). On the following day the foreign body was passed by rectum.

CHINESE BOUND FEET

BY JOSEPH L. HARVEY, M.D.

Roentgenologist, Canton Hospital

CANTON, CHINA

THE binding of women's feet into the so-called "Golden lilies" or "Lily feet" probably originated during the first centuries A.D. There is not sufficient trustworthy evidence as to when or why the custom originated. When pressed for an answer the Chinese usually give one of two answers: "Small feet were thought beautiful," or "To keep wives from running away." In the writer's opinion the latter is probably the true explanation.

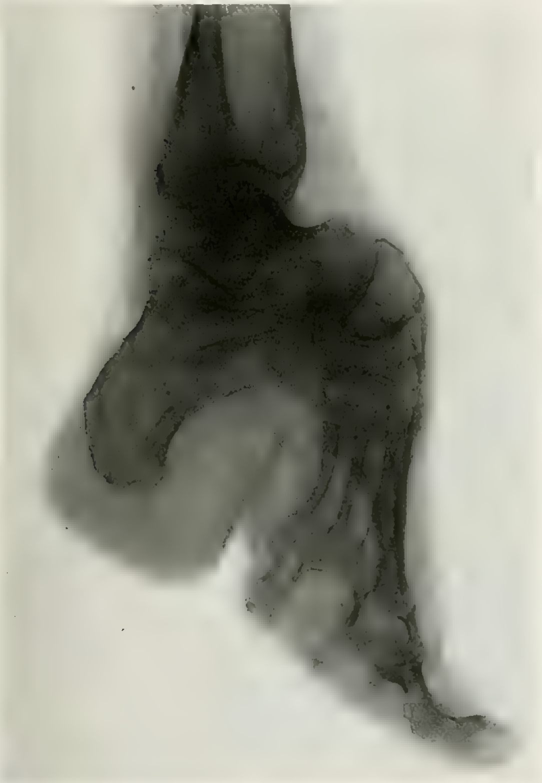


FIG. 1. True bound foot. Chinese woman eighty-two years old, and 4 ft. 6 in. tall.

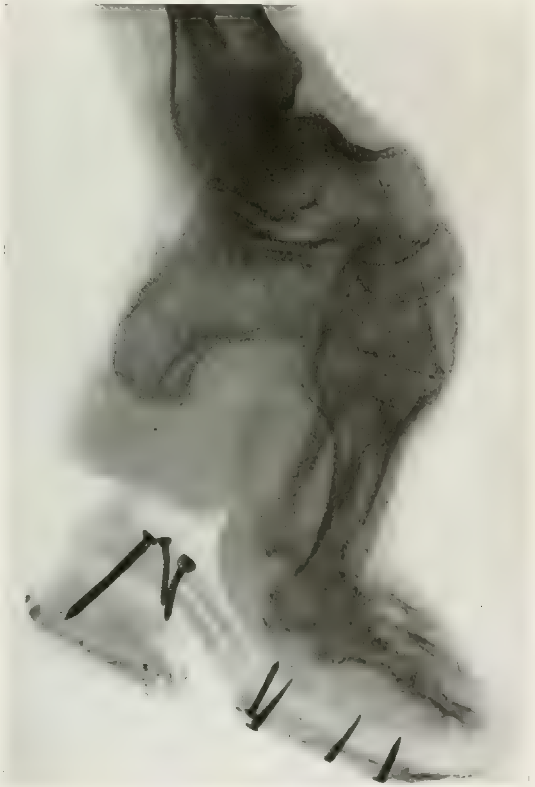


FIG. 2. Foot of Chinese woman forty-six years old and 4 ft. 9 in. tall. Note toes are not bound under foot as in Figure 1.

The binding usually begins when a girl is three or four years old. It consists in binding the toes under the foot and back against the heel. The result is a badly deformed foot, like a knob on the end of the leg. These women are only able to hobble very short distances.

It is now illegal to bind feet, but the practice is still maintained in some of the interior regions of China. Some of the Chinese women have unbound their feet with varying degrees of improvement in the shape and a corresponding improvement in walking ability.

The accompanying roentgenograms should be of interest not only as curiosities but from the light they may give on the question of bone formation and its relation to tension and pressure.

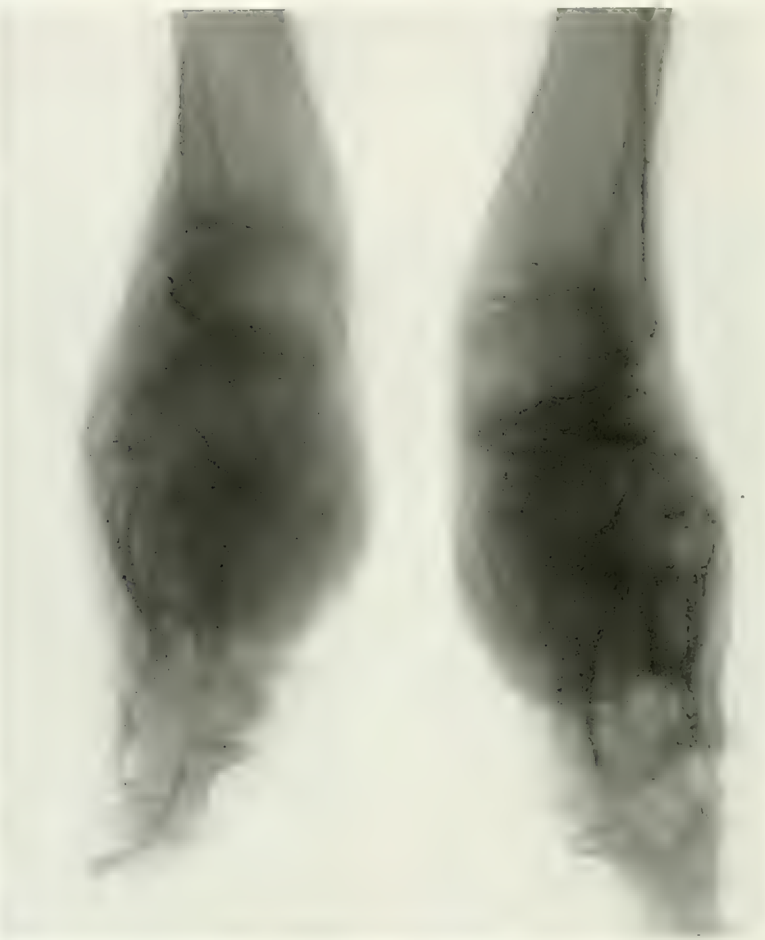


Fig. 3. Anteroposterior view of Figure 1.

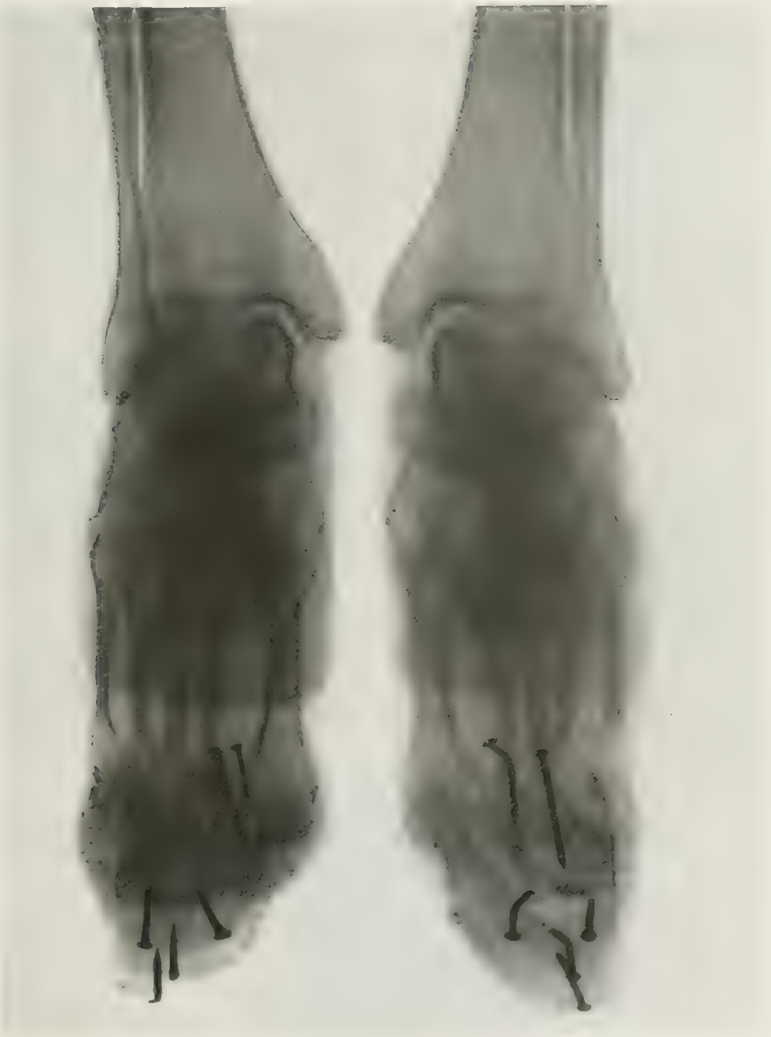


FIG. 4. Anteroposterior view of Figure 2.

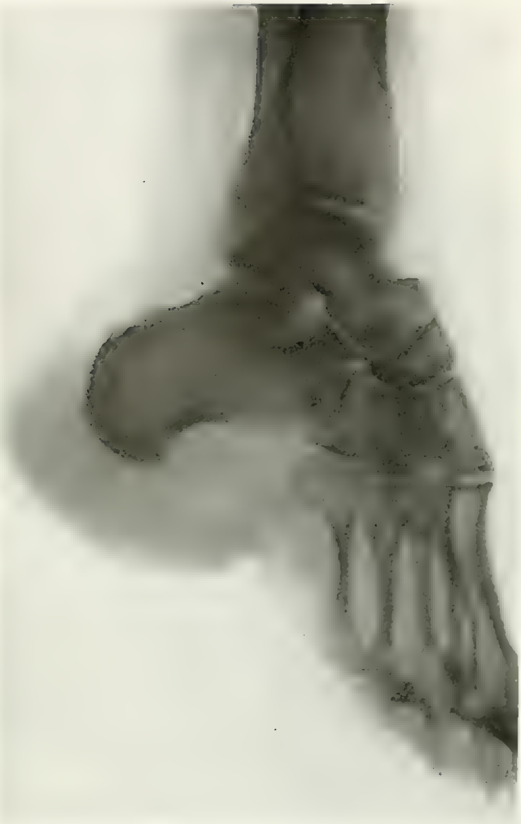


Fig. 5. Bound foot which has been unbound for a number of years. Chinese woman forty-two years old and 4 ft., 10 in. tall.

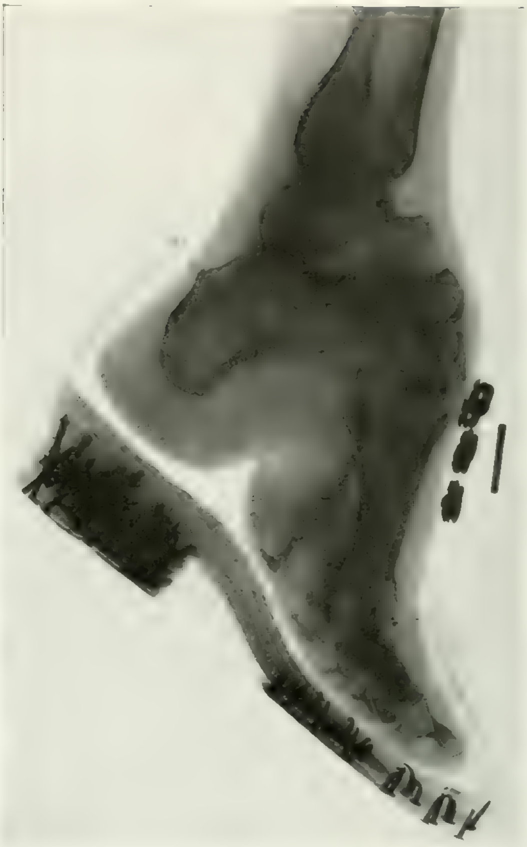


Fig. 6. True bound foot. Chinese woman forty-four years old and 4 ft., 8 in. tall. Note toes bent backwords and bound under foot.

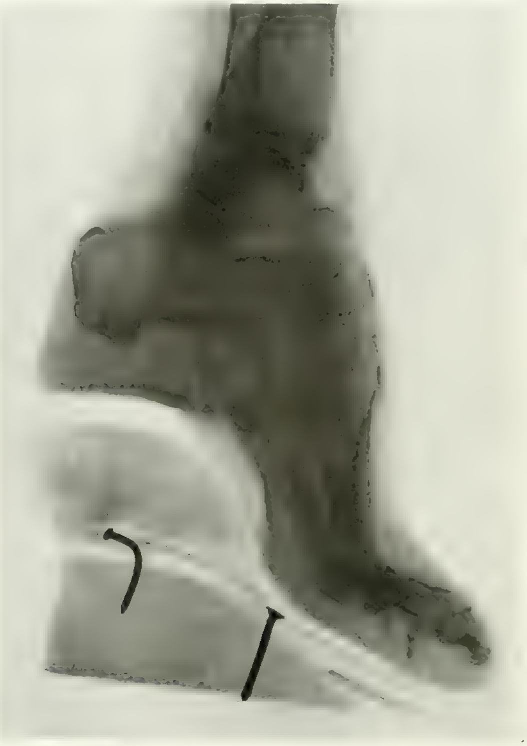


Fig. 7. Bound foot which has been unbound and shoe adapted.

A SIMPLE METHOD OF IMMOBILIZING PATIENTS IN THE STANDING POSITION

BY C. HARVEY JEWETT, M.D.

Clifton Springs Sanitarium

CLIFTON SPRINGS, NEW YORK

THE following method of immobilizing patients in gastrointestinal and chest radiography is described, with the hope that it may be a distinct aid in improving technique in these examinations and also add an element of safety.

The apparatus is simple in construction and can be readily adapted to the usual upright stereoscopic plate shifts. It consists of a light canvas band stretched across behind the patient which can easily be adjusted to the height desired and made fast by a simple locking device. The whole apparatus can be constructed in a very short time; and the author has found it particularly useful with patients who are unsteady or nervous.

The accompanying diagram and illustration show the details of construction when adapted to the old style K. K. vertical stereoscopic shift. On the left side there is a vertical bar of wood set up on blocks at each end so as to allow a six-inch canvas band to be looped around it and made fast. This permits the raising or lowering of the band to the desired position.

On the right side a six-inch thin board is mounted vertically, in the center of which is a raised one-half-inch wood strip. Over this strip a grooved stick is fitted. This is fastened at the bottom with a leather hinge and can be readily held in place by an ordinary hinged hasp at the top. This hasp is bent at a right angle so as to drop down over and hold the stick in position after the canvas band has been stretched across. Raising the hasp and allowing the grooved stick to swing down is all that is required to release the patient.

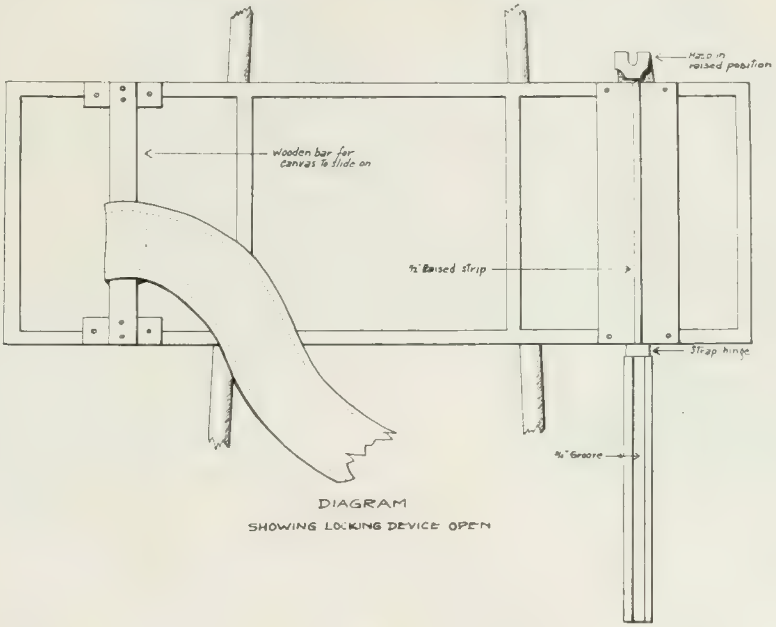


FIG. 1.

The added element of safety was recently demonstrated in the author's experience when a patient fainted just as the exposure was made. The canvas band was sufficient to hold the patient in position and prevent him from falling back against the tube until assistance could reach him.

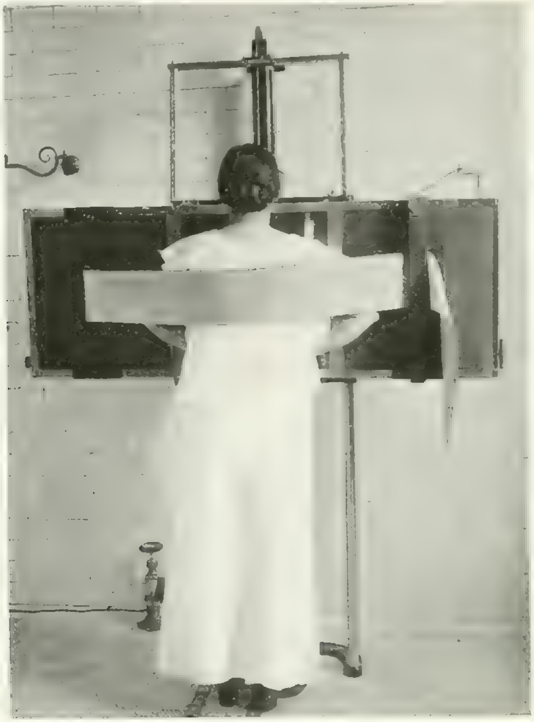


FIG. 2. Showing patient in chest position.

TIME-SAVING DEVICE FOR SKIN THERAPY

BY SZE-DAU TSIANG, M.D.

Peking Union Medical College

PEKING, CHINA

ALL roentgen skin therapists must have experienced considerable loss of time in setting the tube at the desired skin-target distance, and in centering the ray upon the area treated. The time-saving device here described aims to do away with both these difficulties. It consists of a piece of square wooden board about ½ cm. in thickness and the exact size of the ordinary aluminum filter. In the center of this board we make a round aperture which should be the same size as that of the tube-holder, so as to avoid possible interference with radiation. At the middle point on each of the four sides of the square board a small hole is made, and a thread passed through each to the hole opposite. The crossing point of the two threads is the center of the aperture and at the same time it indicates the central rays. At this point, a piece of thread is tied, and a small glass bead fastened to the free end of the thread. The length of this thread should correspond exactly to the desired distance from the center of the target—say 10 in. (Fig. 1). Therefore, the point touched by the bead is the center of the ray and also the desired distance from the target (Fig. 2).

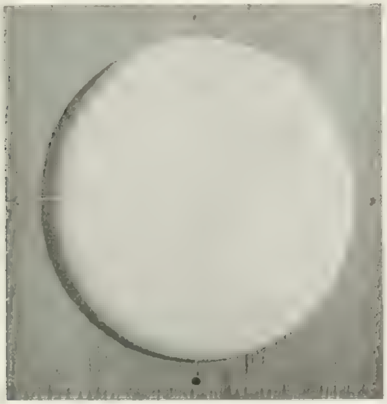


FIG. 1. Wooden board with threads in position.

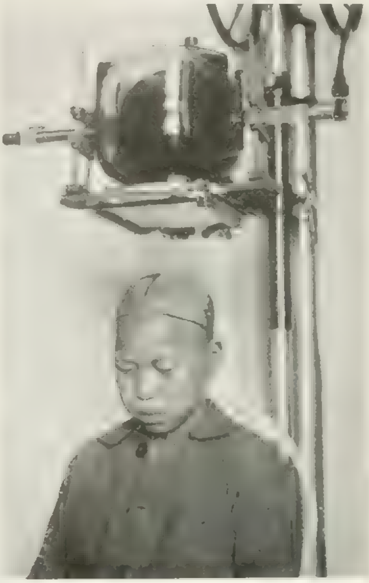


FIG. 2. The device in place.

Take a case of ring-worm for illustration: After the scalp is marked off by Adamson's method, the board is placed in position, being slid on to the tube-holder as is done with the filters. The tube is then manipulated so that the bead barely touches the skin and the center of the area treated. Thus the central ray and the desired distance are secured. In my own experience I find I can save one minute in getting the desired distance and the central rays for each area, by using this device. Thus, in each ringworm case I save five minutes. This device is simple to make and inexpensive; it is particularly useful to roentgenologists handling big skin clinics.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

FIFTH ANNUAL MEETING EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY

CHALFONTE-HADDON HALL, ATLANTIC CITY, N. J., JANUARY 24–26, 1923.

MEETING OF EASTERN SECTION

The meeting of the Eastern Section of The American Roentgen Ray Society will be held at Haddon Hall, Atlantic City, N. J., January 24, 25 and 26, 1924.

Applications for hotel reservations should be addressed to Chalfonte-Haddon Hall. These hotels have a large number of winter guests, and it is recommended that reservations be made early.

Application for a place on the program should be addressed to Dr. Thomas A. Groover, 1621 Connecticut Ave., N. W., Washington, D. C.

It is hoped that the program for this meeting will measure up to the high standards of the past. One evening will be devoted to a Lantern Slide Exhibit. Those desiring to participate in this exhibit should advise Dr. Groover at an early date of their intention to do so, indicating the number of slides to be shown.

OFFICERS OF THE NEW YORK ROENTGEN SOCIETY

At a recent meeting of the New York Roentgen Society the following officers were elected:

President: Dr. F. M. Law, New York City.

Secretary: Dr. T. L. Le Wald, New York City.

Treasurer: Dr. John Remer, New York City.

Member of Executive Committee: Dr. C. Eastmond, Brooklyn.

REPORT OF THE LEONARD PRIZE COMMITTEE

Gentlemen:

We have received for consideration by our Committee for the Leonard Prize, eleven contributions. All are of merit. At least three or four are of sufficient merit to justify the awarding of such a prize. Unfortunately, the Society does not have the funds necessary to award $1,000 to each one of the men who have contributed these superior papers.

There are three papers of very superior merit, which are so close in value that it would be an injustice to award the entire prize to any one to the exclusion of the others. Therefore, the Committee has deemed it best to divide this price as follows:

To Prof. Wm. Duane, the first prize of $500.00, for his contribution on "Ionization Methods of Measuring X-Ray Dosage."

To Mr. G. Failla and Mrs. E. H. Quimby, the second prize of $300.00, for their contribution on "The Economics of Dosimetry in Radiotherapy." (From the Radium Research Laboratory of the Memorial Hospital.)

To Dr. J. W. Mavor, the third prize of $200.00, for his contribution on "Studies on the Biological Effects of the X-Rays."

With honorary mention of the very excellent paper by Dr. C. C. Little and Dr. H. J. Bagg. "The Occurrence of Heritable Abnormalities in Mice and Their Relations to Exposure to X-Rays."

George E. Pfahler, M.D.
Frederick Baetjer, M.D. *Committee*
Geo. W Holmes, M.D.

BOOK REVIEWS

Clinical Roentgenology of Diseases of the Chest. By H. Wessler, M.D., and L. Jaches, M.D. 578 pages. Troy, N. Y., 1923.

In no country is the roentgen-ray method of diagnosis more freely used than in America. In large city hospitals probably from fifty to seventy-five per cent of patients admitted are examined in this way. Yet, until very recent years, authoritative and reasonably complete treatises in the English language on the various phases of roentgen-ray diagnosis have been lacking. The seeker after detailed information has been compelled to turn to the foreign literature, especially the German.

Clinical Roentgenology of Diseases of the Chest by Dr. H. Wessler and Dr. L. Jaches fills this long-felt need in the roentgen-ray field. The book, however, hardly requires this excuse for its existence. It is the product of years of experience of careful observers in a large hospital where good work is carefully checked up. There is no attempt at discussion of the literature or critical consideration of divergent views. On controversial points, the writers state, they have not hesitated to present their personal opinions, influenced by the best thought on these questions. Various readers will undoubtedly find points on which their personal experiences have led to opinions differing from those expressed by the authors. Such differences are stimulating and lead to profitable investigation and discussion.

For instance, in regard to the question of "peribronchial" tuberculosis, the authors' objection to the diagnosis of tuberculosis from widened and heavy bronchial shadows will be met with unqualified approval. The fact that such shadows are frequently the result of pulmonary congestion from causes other than tuberculosis can not be too strongly emphasized. However, that "peribronchial" tuberculosis does not exist in the sense of involvement of the lymphoid-cell deposits along the bronchi is by no means proven. In fact, aside from the roentgen plate, there is considerable experimental evidence that tubercle bacilli may get into the pulmonary lymphatics from the blood stream or from the air, and, floating down the lymph channels toward the hilum, be filtered out in passing through a succession of these little nodes located along the bronchi and arteries throughout the lung. In these deposits the organisms may gain a foothold and begin to proliferate, producing peribronchial tuberculosis. However, this very interesting question cannot be discussed satisfactorily here. This experimental evidence is presented by Krause,[1] whose work is very interesting in connection with the explanation of the shadows of tuberculous lesions as seen on the chest plate.

The subject of diseases of the chest is considered in ten sections, each of which, with two exceptions, deals with an anatomical subdivision of the chest, e.g., the pulmonary vessels and circulation, the trachea and bronchi, the lungs, the pleura, etc. A section on the normal lung and one on surgical diseases of the chest constitute the two exceptions. The significance of the different variations from the normal is discussed as well as the roentgen-ray manifestations of the various diseases to which the structures are liable. The text is profusely illustrated with approximately two hundred and forty reproductions of well-chosen, clear chest plates. Here and there are short abstracts of clinical histories which illustrate as aptly as do the halftones the points the authors desire to make.

In the roentgen-ray study of the chest the authors believe the fluoroscopic examination to be of vital importance. The screen, however, does not replace the plate, but rather supplements it, giving information which cannot be obtained in any other way. They feel that, with occasional exceptions, stereoscopic plates give no more information than the single plate. They stress the necessity of technical excellence and prefer a target-plate distance of four feet to the usual twenty-eight or thirty inches, as there is much less distortion of shadows. With an unscreened plate at this distance they use a gas tube with a relatively high voltage and milliamperage.

---

[1] Krause, Allen K. Experimental studies on tuberculous infection. *Am. Rev. Tuberc.*, March, 1922, vii, 1.

Richard C. Cabot once remarked to his students that he believed more mistakes in diagnosis were made through errors in the detection of variations from the normal in physical examination than through errors of judgment in the interpretation of the evidence at hand. The opposite seems to be the case in the interpretation of chest plates. It is usually easier for the trained observer to detect abnormal shadows than it is for him to interpret these shadows in clinical terms. In this book such pitfalls are pointed out and the necessity of making the interpretation in the light of all the facts of the case is emphasized again and again. This correlation of clinical and roentgen-ray evidence requires close cooperation between clinician and roentgenologist, as the ideal combination of the two can rarely be found. Without this correlation roentgen-ray diagnosis will not attain its maximum accuracy and usefulness. The authors are justly enthusiastic for this method of examination which they present so well, but their enthusiasm is tempered with an intimate knowledge, born of years of experience, of its limitations, which they point out as frankly as its successes.

The worst that can be said about this book is that it contains an unusual number of typographical errors. It is a much-needed addition to roentgenological literature. Besides those who devote their entire time to this field, it will interest all medical men who have occasion to turn to the roentgen-ray method for help in the diagnosis of chest conditions, and it will be a valuable reference book for the medical student.

Ross Golden.

TRANSLATIONS & ABSTRACTS

The Biology and Radiation Therapy of Cancer. Perthes (Tübingen). Abstract of Proceedings of a Special Meeting of the German Roentgen Society held in conjunction with the Congress of the German Gynecologic Society at Heidelberg, May 26–27, 1923.[1]

Four conceptions enter into the roentgen cure of cancer: (1) The rays kill the carcinoma cells; (2) the rays damage the carcinoma cells, general and local resistance of the organism nullifies them; (3) the rays stimulate the connective tissue about the cancer focus to a local resistance; (4) the rays, by weak radiation of the body aside from the carcinoma, or even by radiation of the cancer focus, give rise to protective substances.

The first conception is to be rejected, for the increase of the ray does does not bring about an increased healing effect.

The third is not the present conception, for circumscribed carcinomata are destroyed by only local radiation with the minimum carcinoma dose, not, however, with small "stimulant doses" (cutaneous carcinoma and cutaneous metastases from mammary carcinoma).

As for the fourth conception, animal experiment has shown that weak radiation of the whole body raises the resistance against inoculation with mouse carcinoma (Murphy, Nakahara and others).

The second conception probably lies nearest the truth. The injury to the carcinoma cells, especially the nuclei, which shortly precedes the protective reaction of the connective tissue is histologically demonstrable in specimens excised at appropriate intervals. The aim of roentgen therapy is the greatest possible damage of the carcinoma cells and the greatest possible preservation of the resisting power of the body.

The varying sensitivity of various carcinoma forms is important. It has been demonstrated by many examples. Because of it, there can be no single carcinoma dose—only a minimum carcinoma dose (Jüngling).

How can one determine for operable surgical carcinoma the ratio of permanent cures for radiation and for operation? For cutaneous carcinoma many permanent cures have been observed, yet there are recidives and refractory cases: thus, a woman who had been cured of a cancroid under the eye developed one symmetrically placed on the other side of the face, which strong radiation did not affect. In carcinoma of the lip, radiation, especially in cases with metastases to the lymph-nodes, has given more recidives than operation. No permanent cure has been attained in a case of growth adherent to the jaw. The proportion of five-year cures from radiation of definitely operable carcinoma of the breast (Krönig's material) lags far behind the results of radical operation at the same stage. Cures of from three to seven years' duration have been observed by Haenisch, Schädel and Sudeck in carcinoma of the thyroid. The operation cannot furnish such results. A good response to roentgen radiation without subsequent cure is frequently observed in thyroid carcinoma. With the added aid of radium, isolated cases of carcinoma of the tongue and of the rectum have been observed to remain free from manifestations for more than three years, yet these are quite unusual results.

A questionnaire sent to the German and Austrian university surgical clinics has established that the directors are generally in accord with the principle that operable surgical carcinomata are to be treated by operation. Exceptions: Refusal of operation by the patient, certain cases of cutaneous carcinoma in old people, carcinoma of the thyroid. The after-radiation of cases of breast carcinoma radically operated upon is endorsed by 13 clinics, and neglected or objected to by 13. The statistics show in part a considerable decrease, in part a considerable increase of recidive following after-radiation. I myself, in agreement with Anschütz, oppose the method employed. Intensive after-radiation of extensive areas has, so far as can be recognized, only damage as its consequence, manifestly through its injurious effect upon the whole organism and its power of resistance. The clinics which present statistics showing improvement (Kiel and Rostock) radiate with small doses at long intervals. The method of exact radiation of the whole danger zone with the minimum carcinoma dose must, at the present stage of development, be shunned as hazardous. Preliminary radiation before operation has in twenty-six clinics been undertaken in only 6 special cases, e.g., by Payr for the lymphatic drainage area of lingual carcinoma with small doses, and by Schmieden for carcinoma of the rectum. The objection to intensive preoperative radiation because of diminished healing power is not established, despite current investigations (August Mayer). Inoperable carcinoma, e.g., of the lip and of the breast, can often be reduced to a definitely operable stage. Complete disappearance of inoperable carcinoma for a number of years seldom follows roentgen radiation—thyroid carcinoma (Haenisch, Schädel and Sudeck up to seven years); inoperable regional lymphatic recidive after operation for breast carcinoma has been observed recidive-free up to four years by von Eiselsberg, and by Guleke up to three years! Great improvement in inoperable regional lymphatic recidive of breast carcinoma is not seldom seen. Death generally follows from distant metastases. The indications for radiation treatment of sarcoma have been clearly established by the work of Jüngling and Küttner.

---

[1] From a manuscript brought from Germany by Dr. Leopold Jaches.

Holfelder (Frankfurt-on-Main). Experience with roentgen therapy of malignant tumors in Schmieden's Clinic. For three and a half years Schmieden's Clinic has been seeking to radiate the tumor region alone with a dose just below the limit of tolerance of the most sensitive tissue in the region, with the greatest possible protection of the surrounding structures. The strict concentration of the dose makes the roentgen ray in a sense a surgical cautery. The execution of this idea has been attained with the aid of the Holfelder field-selector. The finer details of the method were developed over a course of years and are even now by no means entirely worked out. But even in the earliest days of the method the treatment of carcinoma became so much more satisfactory than it was before, that Schmieden at the Surgical Congress of 1921 and at the Frankfurt meeting of the Roentgen Therapeutic Society committed himself to an increased appreciation of the value of roentgen treatment. He stated, however, with all emphasis, that operable carcinoma always calls for operation and not for radiation. Therefore roentgen therapy in Schmieden's Clinic is definitely limited to cases of inoperable carcinoma and as an adjuvant to the radical operation, in the sense of prophylactic radiation before or after operation. It is not to be expected that in the first years the Schmieden Clinic can show any considerable percentage of cures in the hopeless inoperable cases. A thorough survey of the clinic material for the years 1919, 1920 and 1921, with an average observation time of two and a half years will show whether the estimate of the value of radiation therapy is valid or not. Yet the observation period is still too short to justify any final conclusion. Nevertheless, one can determine in what direction this is leading, and such a survey is now in order, to form a basis for one's procedure. For the judgment of the cases of cure, the most rigorous establishment of the diagnosis is necessary. Only when the histologic proof of the correctness of the diagnosis has been established in the clinic's own laboratory by Professor Klose, have the cured cases been included in the statistics. All cured cases in which the diagnosis may be ever so slightly open to doubt have been excluded. Consequently, the number of lasting cures appears considerably smaller. But in spite of this, the Schmieden Clinic has continued to affirm the value of roentgen therapy for inoperable carcinoma. Still more important is the question whether the prophylactic radiation has bettered the operative results or made them worse. The contradictory experiences of the Tübingen and Kiel clinics have cast great confusion over this matter, which is to be cleared up only by a study of the technique used. In the Schmieden Clinic during the time under consideration, prophylactic radiation was administered in 43 cases of carcinoma of the breast operated upon with an unquestioned diagnosis established histologically. Of these patients, 30, or 70 per cent, are living free from recidive after two and a half years. Individual investigation according to the grouping of Steintal indicates that the percentage of cures in Group 2 has not changed. It is hardly to be considered that within the next half year the number will fall appreciably. Thus my view is confirmed that the prophylactic after-radiation of cancer of the breast is a definitely useful adjuvant to the operative treatment. During the same time, an attempt at cure of local recidive and local or distant metastasis of cancer of the breast was made in 32 cases. Of these, 5 patients still live free from any manifestations. All these were hopeless cases which without roentgen therapy would have succumbed. Even in the fatal cases there was a temporary complete success in the majority, so that some patients appeared well up to two and a half years. The 14 per cent of cures in this hopeless material is so significant that a therapeutic attempt is worth while in every case. On the other hand, the percentage is not sufficiently high to justify following Kreuter in relying on roentgen treatment sufficiently to give up the radical operation for cancer of the breast in favor of the older less radical methods. I emphatically dissent from Kreuter's proposition.

Fifty-one confirmed cases of carcinoma of the rectum were handled during the same time. Of these, 57 per cent were inoperable. Fifteen patients, or 28 per cent, are living today, still well and recidive free. The best operation statistics show 10 to 12 per cent of three-year cures when the inoperable material is included. The combined method, in which surgery and roentgen therapy are most closely associated, shows results more than twice as good as surgery alone, for the two-and-a-half year observation period. The roentgen therapy of carcinoma of the stomach is still in the experimental stage, yet there are found cases of great improvement, though not of permanent cure, during the period under consideration. The esophageal carcinoma also still presents great difficulties, so that no permanent cure has been attained. Only the carcinoma of the thyroid shows markedly favorable prognosis. Three cases were treated, and all 3 patients still show clinical cure.

Ten cases of carcinoma of the tongue were treated, with only one cure that has lasted two and a half years. This case appeared at the beginning of treatment to be the most unfavorable of the lot.

Of 145 inoperable carcinoma exclusive of cancroid, 13, or 8.5 per cent, are well and recidive-free after two and a half years. These include a striking proportion of cases of recidive or metastasis. It seems that in general, recidive and metastasis of carcinoma react better to roentgen treatment than the primary tumor, which confirms my view that operable carcinoma, with the exception of thyroid carcinoma, should always be operated on, and that one should not compromise the prospect of surgical cure by experimenting with radiation.

As regards sarcoma of connective tissue, the results are quite otherwise. Of 14 cases in which diagnostic excision had been done, only 2 patients are living and well today. In the same period 14 patients were treated with roentgen rays without any surgical intervention, and of these, 6 are still living and 1 appears entirely cured. This difference clearly indicates the duty to warn against diagnostic excision or incomplete operation in sarcoma, since the prospect for cure is extraordinarily diminished thereby, and furthermore the diagnostic excision offers the least help in the borderline cases. Roentgen therapy with the strictest surgical forbearance furnishes, in sarcoma at least, the same duration of cure, but without mutilation, as the most radical and mutilating surgery. Therefore sarcoma cases should be only radiated and not operated upon.

In contrast to the value of the radiation therapy in the Schmieden Clinic with the technique using the Holfelder field-selector, the damage resulting has been extraordinarily little. In more than 1,000 intensive radiations with this technique, only 5 cases of roentgen injury occurred, and of these, 3 were of only a transitory nature. All 5 cases are accounted for by technical errors which it was possible to eliminate during the further development of the technique. The lasting damage was so slight that modern roentgen therapy with correct technique can be regarded as a thoroughly safe method of treatment.

Rost (Freiburg). The roentgen treatment of skin-cancer. Cancer of the skin in all its manifold forms is a true cancer, but of relatively benign character. The expression "epithelioma" instead of "cancer" should not be used, but reserved for benign epithelial tumors of the skin. From a roentgen-therapeutic standpoint, cancers of the skin are to be classified as primary and secondary. The latter arise upon the ground of previously existant diseases of the skin, or as metastases from cancer of internal organs. A conception which the author has accepted applies to the secondary cancers: the "tumor bed" (Brock) has an unfavorable outlook for cure as compared with primary skin-cancer of the same histological type. An exception to this is the cancer arising upon senile keratosis, which in this point may be regarded as equivalent to a primary growth.

The primary cancers of the skin may be usefully classified according to Darier as (1) prickle-cell, (2) basal-cell, and (3) mixed or metatypic. They are roentgen-sensitive according to the preponderating type of cell. The basal-cell growths are the most sensitive, the prickle-cell relatively little so; that is, in these cases we have the most failures. The mixed-cell occupy an intermediate position. It must be noted, however, that the histologic picture does not justify hard and fast conclusions as to the roentgen-sensitivity. In isolated cases there occur biological peculiarities which are still in part not understood, in part referable to characteristics of the surroundings of the tumor, the so-called tumor bed (for example, carcinoma terebrans: carcinoma consisting of very roentgen-sensitive basal cells, in a tumor bed of bone which reacts very poorly to the ray). With the skin-cancers go sarcoma and sarcoid, which in part respond well to the ray (with the exception of the melanosarcoma), but are rare. In regard to the treatment, the author agrees with Perthes: operative removal is indicated when this is technically possible with a view to the cosmetic effect. As contraindications to operation must be considered old age, definite constitutional diseases (diabetes, hemophilia etc.) or local disease of the involved region of the skin. Also, many patients refuse operation because of the belief common among the laity that carcinoma of the skin is relatively benign. All cases which for these various reasons are inoperable are to be radiated. Roentgen and radium rays are by and large to be regarded as equivalent: changing from one to the other can be of use in refractory cases. In respect to the method used, the author observes but a few cardinal principles: the establishment of a carcinoma dose he regards as impossible because of the varying biological reactions of different cancers to the ray, but this does not preclude the establishment of the minimal or normal dose which is based on experience. In the Freiburg Skin Clinic the author uses for this 30 X/3 mm. Al or 40 X/4 mm. Al. These doses, not too frequently repeated as to number or length of interval, he regards as the biologic doses, since he believes that they have an adequate effect on the cancer tissue proper, without too much damage to the tumor bed which is, in respect to healing the cancer, already badly diseased. In the latter conception, the connective tissue (fibroblasts and histiocytes) and also the vascular apparatus play an important rôle. In cases which are refractory to the biologic doses, the author radiates intensively with a deliberate overdose, even producing roentgen ulceration (caustic dose). Because of the "fleckwise" effect of the rays (Rost) this method does not protect completely against relapses; but in skin cancer, these are clinically and histologically easy to recognize and to deal with. It goes without saying that the roentgen ulcer is not a pleasant consequence, but it is the lesser of two evils. The question of the value of radiation of the regional lymph-nodes (Brock) in demonstrated or suspected metastasis is not at present settled. In this connection it may be pointed out that the general condition of the patient plays a definite rôle in the cure of cancer, and that it may be so deteriorated by extensive radiation of the lymph-nodes that harm results instead of good.

The author does not venture to give statistics, since the literature is already full of incomplete examples which lack the statement of factors necessary for judgment of the subject Comparisons are therefore in no way possible. The author closes with the hope that future communications will be more explicit in this respect, so that scientific progress will not be more explicit in this respect, so that scientific progress will not be blocked by obscurity and inexactness.

Opitz (Freiburg). The biology and clinical aspects of the roentgen therapy of the gynecological cancer. The author recommends a combination of radium and roentgen treatment. Experiences with the biology of carcinoma should be assembled. Cancer even in the beginning is not a purely local disease, but an expression of a general or local disposition upon the ground of which arises the cell-growth which we call cancer. We can hope to speak of cure, therefore, only when the disposition to cancer is destroyed. At present there is no indicator to show when this state is reached. The author sees in the cure of carcinoma a *biologic* problem. Many animal experiments are necessary, but the results cannot be applied in the raw stage to man. There are great differences to be considered. The progress of treatment cannot be followed histologically in man, because removing the specimen is hazardous to the patient. The conception that a definite dosage, e.g., the carcinoma dose, is necessary to destroy the cancer focus, is wrong. The physical measurement of the ray (Kroenig) was a great step forward, but it does not solve the biologic aspect of the cancer problem. None of Kroenig's patients has remained cured who received large doses. Those of my own patients who have remained well the longest have received smaller doses. On the other hand, vigorously growing carcinoma rests were found in the connective tissue which the ray had rendered completely necrotic. The ray does not destroy the cancer cells only. Much rather, it is a battle between the parasitic invading cancer cells and the body. If the power of resistance is not sufficient, the cancer is the victor. Cancer can disappear spontaneously (Czerny). Skin carcinomata have been cured with the internal use of arsenic alone (Lassar). Detached cancer cells are overcome daily without forming metastasis in the blood and lymph-nodes. The question of the stimulant effect on remaining cancer-nests is not solved. The stimulant effect of the short waves is not recognized by some authors (Holzknecht). A regular stimulant effect has not been demonstrated on animals and plants. The Arndt-Schulz law is not applicable with certainty to the roentgen rays. The possibility of stimulation is, however, not excluded, and there may be a formative stimulation in that cell destruction incites the surrounding tissue to growth (Weigert), perhaps even also a functional stimulation. The important factor in the course of cure is the growth of the connective-tissue, but we do not know whether this is secondary or primary. In spite of their sensitivity in the living body, lymph cells outside the body are not killed, as is shown by experiments in vitro. Roentgen rays are thus no agent comparable to the chemical agents in medicines. It is certain that all cells are attacked by the roentgen rays, of course in varying degree. It is not a matter of the effect on one kind of cell, but an indirect mutual relation of the cells. Investigation of the effects upon the body after radiation indicates that the manifestations are practically the same as what we recognize as symptoms of hypertonia of the vagus, and also of the vegetative nervous system. The author has seldom found vagotonia in cancer patients. The vagus is most active in youth, and in this period there is no disposition to cancer. Stimulation of the vagus by radiation! Also the skin reaction is of significance; marked skin reaction is to be avoided, for these cases do the worst. Large skin fields = much nerve stimulation. Also an influence on the vegetative nervous system via the endocrine glands is possible, and chemical influences are conceivable. So must the question of the effect of cholin still be investigated. Cholin set free from the radiated brain when the hypophysis is radiated? The author advances the hypothesis that the effect of radiation is a stimulation of the vegetative nervous system, the vagus preponderating.

For the practical treatment, the proposition falls under two heads:

1. Putting an end to the carcinoma focus, for which radium seems better than the roentgen ray. No overdoses, no damage to the surrounding tissues, large skin-fields, repetition of small doses.
2. Bringing up the condition of the body to a state in which it can help in the combat. For this the roentgen ray is but one of many aids employed.

The author will not speak of curing carcinoma, but only of prolonging life without suffering.

Statistics: All cases were confirmed histologically by Aschoff. From January 1, 1919, to March 31, 1922, 150 cases of carcinoma in which after-data were had.

90 cases, carcinoma of the cervix:
  24 operable cases, of which 16 patients live, 8 are dead.
  66 inoperable cases, of which 29 patients live, 37 are dead.
42 cases, carcinoma of the body of the uterus:
  25 operable cases, of which 20 patients live, 5 are dead.
  17 inoperable cases, of which 5 patients live, 12 are dead.
18 cases, carcinoma of the breast:
  6 operable cases, of which 2 patients live, 4 are dead.
  12 inoperable cases, of which 7 patients live, 5 are dead.

Werner (Heidelberg). The treatment of surgical cancer with radioactive substances. In the treatment of cancer, radioactive substances are employed in the form of radium or mesothorium, radium emanation or thorium X. Some forms of application have been discontinued; for example, the intravenous injection of radium or mesothorium solutions or of emanation in physiological saline, because the general effect is too strong in proportion to the on the tumor. Furthermore, the intra-arterial injection, which is very efficacious, requires uncommon anatomical conditions for its execution. Likewise the intratumoral injection of radioactive emulsions of insoluble salts is not feasible, because the costly substance is lost.

The extratumoral radiation with distant and filtered radiant bodies which are similar in effect to the *x*-ray, notwithstanding the high penetrative power of the γ ray and the relative size of the radiating surfaces which diminishes the divergence of the rays, is superior to the cone of the roentgen rays only up to a depth of about 5 cm. Even massive amounts of radium cannot show a greater effective depth. The reason for this is thought to be that as the hardness of the ray increases, the scattering increases in comparison with the absorption. There is no certain explanation.

This form of radiation can also be undertaken with glass capillary tubes filled with emanation.

The extratumoral radiation by introducing the radiant object into a preformed opening in the body requires great precaution against burns in consequence of the strong divergence of the rays. In many cases it is advisable to add supplementary doses from outside fields, since otherwise the inhomogeneity has too destructive an effect. The correct summation requires great experience.

Intratumoral radiation, which formerly was achieved by introducing radium tubes through canals made by the cautery or the trocar, can now be accomplished by the use of glass capillary tubes filled with emanation, or of steel needles containing radium.

While the dosage for external radiation depends upon the strength of the source of the radiation, the distance, the size of the radiating walls and the duration of the exposure, in intratumoral radiation there is the added factor of the volume of the tumor.

The biologic effect of the α ,β, and γ rays on tumors is not markedly different, at least in histologic pictures; it only appears that the β rays produce somewhat more inflammation than the γ. Resistant tumors are better dealt with by the puncture method with ultilization of the β rays.

The so-called "stimulant effect" of weak radiation upon the tumors is not in the sense that a certain dose directly stimulates the tumor cells; it appears much more as if a fortuitous concentration of the radiation occurs with spontaneous cyclic variations of growth. Against a direct dependence upon any given dose is the circumstance that weak and strong doses quite seldom cause corresponding stimulation. When the radiation is overwhelmingly strong, the environment of the tumor can suffer more severely than the tumor itself. Then the picture of "stimulation" is due to damage to the enveloping tissue. While with thermal stimuli with a quite definite strength of stimulus (e.g., at a critical temperature) a rapid growth occurs in even normal tissue cells with a picture of slight cell damage, there is no such relation demonstable between strength of radiation and tumor-cell reaction.

Acute burns as well as delayed effects (among them the development of cardinoma upon the altered skin) are as great risks with external radiation with radioactive substances as with roentgen radiation, only thelesser extent of the injury makes the prognosis for recovery better. Especially unpleasant are radium burns in preformed cavities (perforation, hemorrhage, etc.).

Preliminary exposure before operations is to be recommended only where it is sought to shrink a locally inoperable tumor, or to mobilize one. After large doses the wound heals much less readily, though not in the same degree, in all parts of the body. Medium doses are better borne, and are often used for this purpose. Where healing by first intention is absolutely necessary, the preliminary radiation is not recommended.

After-radiation following operations is a question only under certain conditions, for usually roentgen radiation is employed on account of the larger fields covered. After extirpation of small tumors or after removal of such from preformed openings (upper jaw, pharynx, etc.) after-radiation with radium is in order. In bone-cavities it is prone to lead to wall necrosis, which however with good drainage terminates harmlessly. The only localities in which so far the application of radioactive substances has been fruitful are as follows: sarcomata of the skull, mostly periosteal or of myelogenous origin, are favorably influenced as a rule. The effect is similar to that of roentgen rays. Of the intracranial tumors, sarcomata of the dura and tumors of the hypophysis have been made to vanish, with a cure period of several years; in general, however, the roentgen treatment is the better. The carcinomata and more especially the sarcomata of the nasopharynx are not infrequently favorably influenced locally, yet they seldom heal completely. In retrobulbar tumors, especially gliomata and sarcomata, the extratumoral radiation is very effective, even if it seldom leads to a complete cure, and is less dangerous than the intratumoral radiation if one seeks to spare the eye. Doses exceeding the single skin dose are to be avoided.

In tonsillar tumors, especially sarcomata, the results are favorable with either intra- or extra-tumoral radiation, even after conservative operation. In tumors of the upper jaw, operation is to be recommended without qualification. Here the treatment of recidive, with cross-fire from the oral cavity and cheek externally, gives better results than the primary radiation. Radiogenic bone-necrosis is recovered from without harm.

In carcinoma of the mucous membrane of the cheek, radiation is worth just about as much as operation. Permanent cures are rare, and refractory cases of the extremest sort occur.

Although carcinoma of the tongue has been treated with apparently permanent cure, operation is very much to be preferred. After-management of recidive is successful only in a few cases. The puncture method seems better than the extratumoral radiation.

Sarcoma of the floor of the mouth reacts favorably. Complete regressions have been observed for two to three years. Carcinoma of this region reacts badly.

Circumscribed sarcoma of the lower jaw is treated as well by radiation as by operation, especially in the young.

Sarcoma of the parotid is accessible to extensive and rapid influence by treatment with both intra- and extra-tumoral radiation. Carcinoma reacts exceedingly poorly. Mixed tumors react relatively well in their sarcomatous portion, but complete regression occurs seldom.

In carcinoma of the larynx there are four methods available: intralaryngeal extratumoral, extralaryngeal extratumoral, and intratumoral with or without laying the tumor free. The results with the last two methods are the best. If the tumor is not laid free, the needle-puncture method is used; otherwise, the introduction of emanation tubes. Damage to the interior of the larynx is to be avoided. According to the newest American statistics, 7 out of 20 operable cancers showed complete regression over from one to many years; the results were considerably worse with extensive carcinoma, showing a few cures lasting several years.

Struma maligna has been shown to respond especially favorably. Circumscribed nodules are best suited to extratumoral radiation, the diffuse forms better for roentgen therapy. Even multiple metastases in the neighborhood and in the mediastinum can be made to vanish. The majority of other tumors of the neck, with the exception of branchiogenic carcinoma, are better treated by roentgen radiation, since in this location the extratumoral radiation can easily cause distant damage by tangential rays. The resistant tumors are therefore reserved for radium treatment.

Although a few cases of carcinoma of the breast have remained apparently cured for a number of years after radium treatment and a permanent cure appears to be possible, the treatment of choice is indubitably surgical. Inoperable and recidiv-tumors when they are large and flat are better treated with the roentgen rays; when they are circumscribed infiltrations they are better treated with radium either by cross-fire of intratumorally. Temporary extensive improvement is frequent, complete permanent cure quite rare.

Of the intrathoracic tumors only the esophageal carcinoma is suited to radium treatment. The introduction of tubes with the esophagoscope, or on an endless thread with the aid of a gastric fistula and under fluoroscopic control is the best. A few apparent cures have lasted more than two years; most cases show improvement only for a year or a year and a half. There are many complete failures. The cases in which diagnostic excision was performed have done more badly than the others.

Of the intra-abdominal tumors, only the sarcomata of children have been favorably influenced by radium. The reason lies in the lack of effective range of radiation, which prevents an adequate dose reaching any but an especially sensitive growth.

Somewhat similar has been the experience with the renal and suprarenal tumors, which in children quickly regress under extratumoral radiation.

The carcinoma of the urinary bladder, which formerly was treated with intravesical radium application with transitory results, seems to react better to the puncture-introduction of radium. The end-results are still not definitely established.

Likewise in prostatic and rectal carcinomata the puncture method is to be regarded as a step forward, even if, because of its limited local effect, it cannot often produce permanent cure. The sparing of the rectal mucous membrane is of great importance.

For sarcoma of the extremities, radium cross-fire is as valuable in many cases as roentgen treatment. The indications are: (1) A desire to avoid amputation until at least a test radiation has been given, which may because of its favorable effect make the amputation unnecessary; (2) constitutional disease which renders the patient a poor risk; (3) inoperability of the tumor or refusal of operation.

The advantage of treatment with radioactive substances is their great adaptability, in their various application forms, to anatomical conditions.

(To be concluded in December issue)

Schall, W. E. A new *x*-ray spectrometer. *J. Röntg. Soc.*, Apr., 1923, xix, 50.

The author refers to a spectrometer recently described by Staunig, March and Fritz, combining, as it were, the methods of Laue and Braggs. The *x*-rays are passed through a crystal, and after reflection has taken place on the internal atomic planes of the crystal, the reflected beam is examined on a fluorescent screen.

In applying the spectroscope to medical *x*-ray practice, the crystal is rotated slowly. It is found at a point to the right or left of the central ray—according to the position of the crystal—the reflected beam first flashes up quite suddenly. Further rotation of the crystal moves the image produced by the reflected beam on the scale away from the central point till it eventually dies out. When the image first apears it is faint, but as the crystal is rotated, there is a rapid increase in intensity to a maximum, and then a fading away. Thus there passes before the eyes on the fluorescent screen the spectrum of the particular *x*-radiation, which is being obtained from the tube. It differs from the spectrum of visible light only in that the whole of it cannot be seen at once, but only the part corresponding to the particular wave-length which the position of the crystal at a particular moment picks out. And moreover, the various wave-lengths in the spectrum are distinguished only by the angle of incidence and reflection and not by various colors, as in the case of visible light.

The point at which the spectrum suddenly flashes up is that of the shortest wave-length which is present in the heterogeneous beam employed. This is called λ_0, and it can be measured with considerable accuracy, to the nearest 0.005 Ångstrom unit. And having measured this λ_0, one has learned very much about the radiation.

In the first place, Duane and Hunt, in examining continuous spectra from *x*-ray tubes, came to the conclusion that the minimum wave-length varies inversely with the voltage applied to the tube. And they enunciated the law that the product of λ_0 in Ångstrom units and the impressed voltage is a constant, namely 12,358. This was subsequently found to agree with results obtained from the law of Planck and Einstein, based on the quantum theory. The measurement of λ_0, therefore, gives an absolute value for the voltage applied to the tube.

As regards roentgenography, tables have been drawn up showing which wave-length of radiation is most suitable for various cases which are encountered, and these tables are being enlarged as time goes on and experience is gained.

As regards radiotherapy, the advantage is greater still. It is possible now to state definitely what wave-length, that is to say, what quality of radiation is employed on a case, and so to compare the results more accurately with other cases. And more especially, it is possible to repeat a dose with very much greater certainty than hitherto.

Webster, J. H. The clinical results of the treatment of malignant disease. *Lancet*, Feb. 24, 1923, p. 373.

The author summarizes the present-day opinion of the value of *x*-ray treatment in malignant disease.

1. With few exceptions, every operable carcinoma should be operated on, with prophylactic postoperative radiation added. 2. In addition to postoperative radiation, a single intensive radiation before operation is coming to be considered important. 3. Practically all inoperable carcinomata and all inoperable recurrences should be radiated. This gives in many cases clinical cure; in others it results in operability, often less bleeding, irritation and pain, as well as limitation of further metastasis. 4. Facial carcinomata, even when operable, can well be treated exclusively by radiation for cosmetic reasons. 5. Sarcomata, as a rule, should only be radiated, certainly in all cases in which operation would cause considerable bodily mutilation. Any increase in size of the tumor after an efficient radiation should not be considered proof of failure to respond: it is usually only temporary. (Schmieden here gives five essential technical requirements.) 11. In the treatment of malignant tumors, along the whole line, *x*-ray work has become superior to radium treatment. 12. The time has not yet come when comparative statistics can show the value of operation or radiation.

The author also outlines at least six different lines of advance in the evolution of radiation treatment, as follows:

1. In the engineering and electrical workshop, improvement of apparatus in power and reliability. 2. In the physical laboratory much remains to be done with measurements of dosage, standardization, calculation of scattered radiation and absorption in animal tissues (this is specially necessary for radium dosage, as Guilleminot and others have noted); the physical side of biological radiation effects —for example, ionization and osmotic changes in cells and fluids—requires much research. 3. In the postmortem room and the pathological laboratory, more statistical and experimental work; apart from immunity and gross animal tumor work, the histological tissue reactions to radiation, as Ewing says, seem to require the combined genius of a Waldeyer, a Weigert, and a Virchow to elucidate them; here new methods like vital staining may be of use; and there is a very wide range for biochemical investigation as to the radiation effects on basal metabolism, etc., and as to the rôle of the cell-lipoids and cell-decay products, etc. 4. Clinical technique is a most important branch requiring much further working out—for example, anatomical technique of radiation applications to different sites of the body on such lines as Holfelder's in Schmieden's clinic, by sectional scaled sheets and models and graphical representation of radiation fields. For the last year I have used scaled drawings in almost every case, and regard this as essential. Auxiliary technique such as diathermy, ionization, radiation stimulation (ductless gland) dosage, or general minimal repeated radiation or other means for stimulating the patients' immunity requires much further research. 5. In relation to surgery enough has already been said as to the necessity and value of team-work, and the best results have been shown so far in several important spheres to have been the result of close cooperation between surgeon and radiologist. Much still has to be learned as to the value of pre- or postoperative radiation, or both, and when the raying should be given in relation to the operation, and in what types and sites of lesion one or other or a combined method is best for the patient. 6. Finally, auxiliary medical measures require much further investigation; though about 100 substances have already been tried, still in the sphere, some day, may be discovered what may displace both surgery and radiation in the treatment of malignant disease. At present the general management of the cancer patient is too often neglected; open air, exercise, diet are not unimportant in recovery, and the rôle of hematinics, colloid, protein, and animal extract injections or transfusion, and of drugs such as arsenic, iodide, etc., is little understood as yet.

Sommer. J. Operation for subphrenic abscess. *Zentralbl. f. Chir.*, Feb. 10, 1923, p. 215.

J. Sommer describes a method of deciding by *x*-rays whether a subphrenic abscess is operable by the subcostal route or whether it will be necessary to cross the pleural cavity. The subcostal route is preferable, provided the abscess cavity extends downward sufficiently to allow of drainage without opening the general peritoneal cavity. This point is determined by laying the patient on the sound side, with the pelvis slightly raised, and screening anteroposteriorly. In the case of gas-containing abscess the gas will rise to the highest part of the cavity—that is, toward the ribs and costal margin—and the extent of the cavity in that direction can be mapped out, assisted by slight alterations in the position of the patient. In the case of an abscess not containing gas, it is a simple matter to inject a little air with an exploring syringe, after withdrawing a corresponding amount of the fluid contents. In the case of a gas-free subphrenic abscess associated with a large pleural effusion the problem of diagnosis is difficult. If the exploring syringe strikes different fluids at different levels, subphrenic abscess may be presumed with fair certainty. If this fails, however, a quantity of the pleural effusion may be withdrawn and replaced by air; with the patient in the lateral position the remainder of the pleural fluid will then fall away from the diaphragm, and the position and mobility of the latter may be observed. If any doubt still remains, an exploratory puncture may then be made, under the guidance of the *x*-ray screen.

FRÄNKEL. Combination of tuberculosis with primary or roentgen carcinoma of the breast. *Strahlentherapie*, xii, 595.

Female, sixty-four years old. Left-sided tuberculosis of the breast, histologically demonstrated. After operation, a fistula occurred, was treated with *x*-rays and cured. Two months later there was a growth the size of a hen's egg in the right breast. Six *x*-ray treatments were given with a 2 mm. aluminum filter; complete disappearance of the tumor. Two years later a large tumor, the size of a man's fist, developed in the right breast. Repeated *x*-ray treatments in the course of the next year. The tumor was reduced to a small remnant after each course of treatment, and the patient did not come for further treatment until it increased in size again. In addition, tuberculous processes in the neck and chin were irradiated. In 1920, four years after the appearance of the first growth in the right breast, it began to grow again, was removed by operation, and proved to be carcinoma. The author considers the possibility of the development of carcinoma on the basis of tuberculosis under the influence of roentgen radiation.

DAWSON, TURNER. The use of radium in the treatment of disease. *Brit. M. J.*, Mar. 17, 1923, p. 464.

Of malignant affections the author finds very amenable to radium treatment rodent ulcers, epitheliomata, lymphosarcomata, spindle-celled sarcomata, malignant disease of the cervix, sarcomata of the nasal passages; and of the non-malignant affections, exophthalmic goiter, early keloids, and certain nevi. They might be termed first-class subjects, because they admit, under favorable conditions, of actual cure. Under second-class subjects—meaning thereby conditions which may be ameliorated but in which a cure can rarely be expected—might be placed carcinomata, lymphadenomata, and splenomedullary leucemia.

Turner has now treated upwards of 200 cases of exophthalmic goiter by means of radium therapy. With two exceptions all derived more or less benefit, both in their general conditions and special symptoms.

In the treatment of exophthalmic goiter and of nevi in children by radiation, radium has the following advantages as compared with the *x*-rays: (1) Absolutely constant emission of rays, and therefore exact dosage possible. (2) Greater penetration of its rays, so that the deeper parts are reached. (3) Saving of time, as the radiation is maintained night and day until the necessary dose has been administered. (4) No noisy, exciting apparatus, so that the treatment can be applied at the bedside without in any way alarming or disturbing the patient.

LEVY-DORN AND WEINSTEIN. The effect of *x*-ray treatment on blood pressure. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, xxviii, Hft. 2.

According to the authors' experiments, it is evident that roentgen radiation in the smaller and medium doses may cause temporary slight changes in the blood, and that these changes are more marked if the region of the 11th thoracic vertebra—the suprarenals—is irradiated. A definite rule in regard to relation of the intensity of the changes to the strength of the dose cannot yet be formulated; the stimulation dose for the suprarenals is not determined. In order to exclude psychic influences in the first examination, apparent radiation was first given.

SANVENERO, F. Sarcoma successfully treated by *x*-rays. *Riforma med.*, No. 10, p. 221.

Sanvenero reports a case of sarcoma of the chest that had twice recurred, treated by twelve roentgen-ray treatments of five minutes each, and entirely cured. No information in regard to milliamperage or dosage is given, except that an aluminum filter was always used and the tubes (Müller water-cooled tubes) were 15 cm. distant from the skin.

WACHTER. The influence of roentgen rays on gastric secretion. *Strahlentherapie*, xii, 556.

The acid values of the stomach seem to be susceptible to the action of the *x*-rays. A distinct generally applicable rule cannot be formulated. In a general way, however, the normal acid values are diminished through a prolonged radiation. On the other hand, an acidity may be removed through a stimulating radiation. The technique of the examination is as follows: Test breakfast, followed on two successive days respectively, by one-fourth erythema dose; another test breakfast, again followed on two successive days by one-fourth erythema dose; then again a test breakfast. Filter 3 mm. aluminum.

Hudson, B., and Sutton, P. G. *X*-ray examination of the chest. *Lancet*, Mar. 17, 1923, p. 535.

The authors summarize their remarks by stating that an inexpert opinion on a roentgenogram is vaueless and often misleading; that many normal chests show distinct mottling and root shadows which need not be referable to tuberculosis. Fluoroscopic and plate examination are essential before undertaking and during the continuance of artificial pneumothorax.

Zumpe, H. Changes in the blood picture and its value in the prognosis of the roentgen therapy of cancer. *Strahlentherapie*, xii, 696.

Zumpe determined the hemoglobin color index, number of erythrocytes, basophilic and eosinophilic cells. With respect to the leucocytes, he adhered to the classification of Schilling into myelocytes, juveniles, rodnuclear and segment nuclear cells. In addition the lymphocytes and large mononuclears were ascertained. Under normal conditions, the blood should contain from 58 to 66 per cent of segment nuclear and from 3 to 5 per cent of rodnuclear leucocytes, the latter as transition forms between the myelocytes and juveniles on the one hand, and the segment nuclear cells on the other. A "displacement to the left," in the sense of an increase of juvenile forms, points to a regenerative process.

In the estimate of the blood picture, the patient's constitution and the type of disease must be taken into extensive consideration, as well as associated diseases, modality and site of the radiation. In malignant tumors, the change of the blood picture goes parallel in a general way with the gravity of the disease. A "displacement to the left" takes place in typical fashion as in an immediate sequel of the radiation, through a stimulating effect upon the blood-forming organs, furthermore as a repair-process in the leucopenia which is produced by all radiations. A return to the normal standard of the blood picture may be credited with a certain value for the prognosis.

Partsch, Fritz. Indications for pneumoperitoneum. *Zentralbl. f. Chir.*, June 24, 1922, p. 905.

Attention is called to a new indication of pneumoperitoneum, possessing surgical importance, namely, its employment before the extirpation of splenic tumors. No matter for what indications an enlarged spleen is to be operated upon, the question of operability depends upon the demonstration of eventual more or less solid and extrinsic adhesions of the splenic capsule to its surroundings, especially the diaphragm and the lateral abdominal wall. In these cases, palpation and ordinary roentgen transillumination are apt to fail, pneumoperitoneum alone providing accurate information as to the extent of adhesions, so that its employment is urgently recommended before every extirpation of the spleen. In the course of the last six months, Partsch had three times occasion to perform a splenectomy, after application of pneumoperitoneum, and transillumination, on the day preceding the operation. These cases concerned an echinococcus cyst of the spleen; splenomegaly in portal venous thrombosis, and in hemolytic icterus, respectively. The lesson taught by these cases was that pneumoperitoneum, without precisely replacing an exploratory laparotomy, may provide sufficient indications, before the performance of splenectomy, of the difficulties to be expected at the operation. The prognosis of the intervention is clearly elucidated, as in the third case where no adhesions were demonstrable in pneumoperitoneum and a favorable prognosis could be rendered. In other cases, where extensive surface adhesions are demonstrable, the surgeon may see sufficient reason to abandon laparotomy. Pneumoperitoneum as a routine procedure before splenectomy will reduce the number of cases in which the operation has to be stopped on account of undetachable adhesions.

Nurnberger, L. *X*-raying of the spleen to control uterine bleeding. *Zentralbl. f. Gynäk.*, Jan. 6, 1923.

Of 25 patients suffering from uterine hemorrhage, 18 were permanently relieved by the treatment. In 2 cases amenorrhea persisted for a considerable period, which makes it appear that secondary effects are exerted upon the ovary (probably direct radiation?). Eight of the patients had adnexal tumors, 10, so-called functional ovarian hemorrhages. In several cases the bleeding stopped within one-half hour of the treatment. In the majority cessation took place on the third day, which is the day on which the coagulant factor reaches its highest intensity.

Patients were radiated while lying on the side, the field being 6 × 8 cm. The apparatus used was the "Symmetry" Coolidge tube, 190 kv., filter 0.5 zinc and 3.0 aluminum, at a distance of 23 cm. The first treatment consisted of ¼ H. E. D. If, as rarely happened, no effect was obtained, three days later an additional ⅔ H. E. D. was given.

Birch-Hirschfeld. The question of damage to the eyes from roentgen irradiation. *Strahlentherapie*, xii, 565.

Report of 2 cases: (1) Repeated intensive multiple-fields radiation of the left eye, in a patient twenty-eight years of age, for sarcoma of the choroid. Strong reaction, blepharitis and conjunctivitis, pains, loss of eyelashes. The cornea looked like frosted glass covered with fine sand grains. The vessels of the sclera presented dilatations and constrictions. After the fourth radiation, a small ulcer appeared in the corner. The inflammatory manifestations subsided again. (2) Man of sixty-one years had been radiated very intensively five times within one year, on account of a small cancroid of the upper lid (elsewhere, no detailed statements). Every radiation was followed by fever, headaches and reddening of the eyes. Vision was gradually lost down to total blindness. Findings: Transparent swelling of conjunctiva, greatly congested and twisted tortuous vessels. This swollen tissue extended in part over the cornea. The cornea itself was entirely opaque, with a dull uneven surface. The iris was barely visible. The blind eye was removed on account of extremely severe pains. Examination revealed glaucoma. The corneal epithelium, which normally consists of cylindrical basal cells, was for the most part transformed into pavement epithelium. The entire cornea was interspersed with infiltration foci. Grave vascular changes, extending to the retinal vessels This observation indicates the need of caution in radiations in the domain of the eye-ball.

Mosenthal, A. Roentgen appearances of pyonephrosis. *Zeitschr. f. Urol.* 1921, xv, Hft. 11.

As pointed out by Israel, a distinction is made in pyonephrosis between: (1) primary hydronephrosis with secondary infection; (2) primarily inflammatory processes of the kidney or the ureter, with secondary retention of the renal products; (3) tuberculous pyonephrosis, or pyonephrosis originating through renal infection in tuberculosis, respectively. From the incipient stage on, these three groups present such entirely different pictures that pyelography absolutely enables us to discover from the *x*-ray pictures, even at the beginning of the pathological process, not only the existing dilatation of the renal cavities, but also to recognize almost without exception the etiological factor for the origin of the pyonephrosis. Lithium iodide, as recommended by Joseph, probably furnishes the best and sharpest contrasts.

Révész. A case of renal calculi mistaken for echinococcus cyst. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, Hft. 5.

In the case of a medical student, twenty years of age, the *x*-ray picture showed in the place of the kidneys two large, nearly circular, sharply outlined shadow formations, with a diameter of 8 cm. on the plate. Echinococcus was assumed, but the operation showed the condition to be due to calculi, the size of a nut to that of an apple, in the remarkably large and distended renal pelvis; although the patient never suffered from renal colic. The contact surfaces of the calculi were very smooth, and besides the two large stones, there were three smaller ones. The calculi weighed together 225 g. The circumference of the largest stone was 20 cm.

Blaisdell, Frank E., Sr. Fracture of the tibial spine. *Arch. Surg.*, Nov. 1922, v, 561.

This article is an experimental study based on cadaver work. There is not much in the textbooks on fractures of the tibial spine except when occurring as a complication of a more serious injury to the knee.

This article gives a careful study of the anatomy of the parts and details experiments.

In the course of his article the author gives the following definition of sprain and fracture:

1. A strain is a stretching of the soft parts with a minimum amount of damage. It is not recognizable macroscopically, causing subjective symptoms.

2. A sprain is a rupture of the soft parts—ligaments or fasciae; recognizable by ecchymosis, loss of function and pain, the symptoms of which are both subjective and objective.

3. A sprain-fracture is, in the milder form, recognizable only by roentgen-ray examination; in the severer form it is recognized as a part of the pathology of dislocation.

In the milder form the crucial ligaments are involved, in combination with a strain or perhaps a sprain of the collateral ligaments, or injury to the menisci; in the latter both the collateral and crucial ligaments are involved, with different degrees of dislocation.

Wetzel. Damage from irradiation treatment with and without changes in the skin. *Strahlentherapie*, xii, 585.

Report of two cases: (1) Roentgen ulcer in the larynx after repeated radiation of the neck from several sides on account of tuberculous lymphoma. Ten radiations, with the exception of the last session, ½ unit dose per field, repectively; at last 1 unit dose, distributed over nine months. Tracheotomy. Death. (2) Necrosis of the larger portion of the left lobe of the liver, after radiation of an inoperable gastric carcinoma in a cachetic woman. Perforation of the stomach occurred as a sequel to the second radiation with three fields from in front (9:9 and 6:8 respectively) and two fields by way of the back with 3 mm. aluminum filter. Peritonitis and death. Autopsy findings: Carcinoma in course of marked retrogression. In the opinion of the pathologists, the disintegration of the stomach at the anterior wall took place independently of the cancer. The necrosis of the left lobe of the liver corresponded to the realm of action of the crossed fire. The occurence of heaptic necrossi by way of five concentric small fields presumably constitutes a unique observation in literature.

Seitz, Ernst, and Rieder, Wilhelm. An apparatus for the exact determination of the central ray in the roentgen treatment of rectal carcinoma. *Zentralbl. f. Chir.*, July 29, 1922 p. 1098.

The radiation of rectal cancer in the Frankfort clinics is usually carried out by way of five ports of entry (two abdominal fields, two sacral fields and one perineal field). The abdominal fields and the sacral fields are usually adjusted at an angle of about 50 degrees to the longitudinal axis of the body in order to concentrate the rays as much a possible upon the tumor. The construction of the authors' apparatus provides for its use in the abdominal and sacral fields, but not for the perineal field, where there is no special difficulty of adjustment. The variably high seat of rectal tumors has been taken into consideration in the construction of the apparatus, which was primarily utilized for the radiation of carcinoma of the rectum. However, this does not exhaust its range of applicability, for this apparatus also proved very serviceable in the treatment of other tumors situated on or near the surface of the trunk, especially when it was desired to reach the tumor from the opposite side of the body, as for example, in a dorsal field of mammary carcinoma. The apparatus is based on the construction of a triangle by means of which the length and direction of the central ray can be accurately adjusted.

Groedel. New form of orthodiagraph. *Fortscrb. a. d. Geb. d. Röentgenstrahlen*, xxvii, Hft. 2.

The author describes the construction of an apparatus which has not so far been manufactured by German firms on account of the existing financial situation. The range of utilization of a similar cross-section designer (the construction of which must be looked up in the original) would be very extensive. In the first place, it would serve for discovering the cross-section of the thorax, with that of the heart and the large vessels, at different levels. In the same way, it would also be possible to ascertain the depth and extent of pulmonary processes, as well as the position and depth of foreign bodies in any part of the body, etc.

Maximow, Alexander A. Studies on the changes produced by roentgen rays in inflamed connective tissue. *J. Exper. M.*, Mar. 1, 1923, xxxvii, 319.

The author, who conducted his work in the Hull Laboratory of Anatomy of the University of Chicago, found very little known about the action of *x*-rays upon living substance. He began his experimental work in 1919.

The action of *x*-rays upon inflamed tissue manifests itself in the first place by a considerable depression of the usual reaction on the part of the fibroblasts. Under normal circumstances these elements begin to divide mitotically during the first twenty-four hours and soon form a layer of new connective tissue, surrounding the foreign body. After treatment with *x*-rays they remain idle, do not multiply at all, or start very late and often the division is abnormal. They undergo a high degree of pathological hypertrophy of protoplasm and nucleus. Instead of mitosis often amitotic constrictions appear in the nucleus. The capacity for collagen formation seems also to be lost.

Simultaneously with these changes of the fibroblasts an intensive edema of the connective tissue surrounding the foreign body is to be noted and in the immediate neighborhood of the latter a thick layer of net-like clotted fibrinous exudate is formed.

No distinctive qualitative changes could be found in the leucocytes and polyblasts. Degeneration was present here only to the same extent as in common aseptic inflammation. But first the rate and the duration of the emigration of all the cells coming from the blood were increased, and secondly there was always a distinct delay in the process of the common transformations usually undergone by the polyblasts on the field of inflammation. The transformation of the polyblasts into fixed resting forms seems above all to be delayed. Therefore, even in late stages, the tissue is overcrowded with the granular special leucocytes and with mostly young, lymphocyte-like polyblasts, whereas in the early stages the local resting wandering cells only slowly undergo mobilization.

Furthermore, in the blood-vessels swelling of the endothelial cells with fragmentation of the nuclei and, in the striated muscles, degeneration of the fibers can be detected. In the latter there occur partly typical coagulation necrosis, partly atrophy, accompanied by loss of striation, separation of fibrillae from one another, relative increase of sarcoplasm, and amitotic division of nuclei.

What the ultimate result of all these changes would be, is as yet not clear. In the case of longest duration, in which sixty days had elapsed since the last exposure, no distinct difference could be found between the exposed and control preparations. Thus one might believe that the cell injuries caused by the *x*-rays, and above all the inability of the fibroblasts to multiply and to elaborate collagen, are again repaired in due time. However, my material is decidedly inadequate in this respect and several cases of long duration should be examined.

It is surprising that the results obtained seem not to agree with the predominating views on the action of *x*-rays on cells. Apart from the endothelium of the blood-vessels, of all the cells present in the field of inflammation the fibroblasts undoubtedly are to be considered as the elements most highly differentiated in a specific sense. I have shown that, as a rule, they do not round up in inflammation and do not produce ameboid cells, but remain unchanged in morphology and, through mitotic division, give rise to the new connective tissue. On the other hand, there can be no doubt that the lymphocytes and the polyblasts are to be looked upon as relatively indifferent cells, endowed with great prospective potencies of development. Thus it might be expected that just the lymphocytes of the inflamed area would be affected in the first place by the rays, as they are in the blood-forming organs, and that the fibroblasts, on the contrary, would be refractory.

But the facts have proved that the most conspicuous and constant changes concern the fibroblasts. They are paralyzed for a long time and made unable to build up new tissue. The fibrinous exudate and the edema might perhaps also depend partly on a direct injury of the colloidal intercellular substance, partly on changes of the endothelium of the blood-vessels, cells which are again to be considered as highly differentiated.

Noteworthy signs of degeneration could not be found in the lymphocytes and polyblasts. But here again the necessary early stages, one to three days after the last exposure, were not available; it is possible that the emigrated lymphocytes are destroyed by the *x*-rays rapidly, in an explosive manner, in twenty-four to forty-eight hours, as in the lymph-nodes or the thymus, or as described by Pautrier in the chronically inflamed tissue of the skin in mycosis fungoides. Their remains might be quickly resorbed and after the last exposure new lymphocytes would have time to emigrate out of the blood-vessels and to pass to the tissue. However, if we take this for granted, there remains another inexplicable fact, concerning the local resting wandering cells—their close genetic relationship with the lymphocytes is beyond doubt and yet exposure to *x*-rays does not seem to affect them. In this connection it may be stated that Soper found that the reticulo-endothelial apparatus, whose cells correspond to the resting wandering cells, is stimulated by small doses of *x*-rays and paralyzed by large doses. For deciding these problems further investigations are necessary.

WELS. The diagnosis and mechanism of idiopathic elevation of the diaphragm. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 2.

The author reports a case in a seven-year-old girl, in whom it was demonstrated by means of a pneumoperitoneum that no hernia, but eventration, was present. If the diaphragm lies high, pneumoperitoneum furnishes practically certain proof as to whether the diaphragm throughout its entire extent is entirely free from the walls of the gastrointestinal segment lying in the thoracic cavity. The gas, insufflated into the abdominal cavity presses on the upper gastric wall, between this and the diaphragm, producing an effect opposite to that of gas within the stomach. This makes possible the fluoroscopic demonstration of the separation between the two organs. Various conditions might interfere, such as extensive adhesions between the stomach and the diaphragm, also such a high grade of gastric pneumatosis that the pressure within the stomach is sufficient to overcome the intraperitoneal pressure which can be applied within the limits of the patient's tolerance. The first condition has not been found in any cases coming to autopsy; whether the latter condition can occur can be determined only on further use of the method. In diaphragmatic hernia, distinction must be made between true and false hernia. The conditions in true hernia have not been determined by this method. In false hernia, an easily recognized pneumothorax occurs on induction of pneumoperitoneum. Of especial importance is the often large amount of air in the stomach, which Hoffman believes to be due to the inefficient functioning of the diaphragm in these cases. Accordingly this collection of air in the stomach has a further unfavorable influence on the eventration by pressure upon weakened diaphragmatic muscle. The author does not agree with this opinion. The chief etiological factor in eventration is the negative pressure within the thorax during thoracic growth, which the less resistant diaphragm follows more easily than the elastic lungs. The gastric flatulence is not the cause but the result of eventration.

SGALITZER, MAX. The roentgen diagnosis of disease of the esophagus, especially esophageal cancer. *Arch. f. klin. Chir.*, cxvi, 53.

The article is based on a large number of cases from the Eiselberg Clinic and illustrated with numerous roentgenograms. Among the conclusions are: The frontal view of the thoracic portion of the eosphagus is adapted to showing a great variety of pathological conditions. A similar techniqe is used for the roentgenological examinations of the trachea from the lateral view. In incomplete stenosis due to tumor, a plate from the frontal view with the patient lying down is sufficient to localize the lesion; then when the opaque meal is swallowed, the degree, length, and form of the stricture is determined: it indicates also a beginning perforation of the tumor into the respiratory passages. Tumors of the esophagus in the upper thoracic portion usually cause more or less definite changes in the position and shape of the respiratory passages. The frontal view of the esophagus makes it possible to demonstrate tumors of the esophagus without a contrast meal, thus directly showing their position and extent. This direct demonstration of these tumors is due to the fact that from this position they show a greater density than the air-containing lungs. The tumors of the lower thoracic portion of the esophagus, which usually pulsate with the heart, can be demonstrated only shortly after meals. With further improvement of the technique of operations on the esophagus, indications for radical operation can be determined on the basis of the situation and size of the tumor, as well as its relation to neighboring organs, as shown by the roentgen rays, with due regard to the general condition of the patient. The degree of stenosis present shows no relation to the size of the tumor; and can therefore not be taken as an indication or contraindication for radical operation.

TANTURRI, DOMENICO. Radium therapy of rhinoscleroma. *Actinoterapia*, 1921, ii, 24.

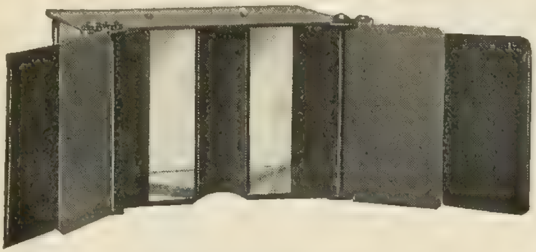
The author reports a case of extensive rhinoscleroma that entirely covered both nasal passages and extended toward the pharynx. Roentgen-ray treatment, continued for a long time, was without result. In October, 1919, radium treatment was begun after a preliminary excision of a segment of the growth to give space for the radium. In the course of four weeks a total dosage of 1,226 mg. hrs. was given followed by complete disappearance of the rhinoscleroma and no recurrence in two years.

BECK. Radium treatment of hemangioma. *München. med. Wchnschr.*, 1921, No. 39, p. 1248.

The author reports 3 cases of hemangioma still under treatment with radium, and 3 other cases in which treatment was completed. The result in all was very good. The course and action of the radiation was such that in the first eight to fourteen days there was a marked increase in the volume of the angioma. Also, the skin and the mucous membrane reacted to the intensive radiation, by an inflammatory reddening and occasionally a superficial erosion, which, however, disappeared within a reasonably short period without any special treatment. This inflammatory reaction caused no serious injury to the skin, since only one case showed a scar, and no other changes in the skin were demonstrable. The author advises no application of the radium within the tumor, since percutaneous, well-filtered radiation gave equally good and perhaps better results. After fourteen days more the tumor became definitely smaller in each case. After a few weeks more, they remained stationary. The radiation was long-continued and intensive. The filtration consisted of $\frac{1}{3}$ mm. lead, 1 to 2 mm. rubber, and several layers of paper or cellulose; therefore only the gamma rays, and of these, only the hardest rays, were used. The radiation must be carried out at first until the tumor enlarges, thus giving a convenient measure for dosage.

CLEAR VISION STEREOSCOPIC BOX

Gives True Reflection of Radiograph Without Fogging or Blurring



Front View Small Size 4 x 4

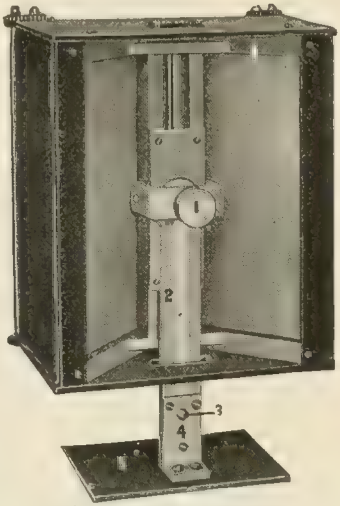
PAT'S APPL'D FOR

1. Tension Screw; 2. Pedestal; 3. Hole in pedestal for mounting when platform not used; 4 & 5. Attachment and platform. This attachment with little or no change can be adapted to most stereoscopic stands.

Prices net

4 x 4" MIRRORS, $75.00 4 x 8" MIRRORS, $100.00

No longer an experiment—an accomplished fact: an optical instrument for your stereoscopic stand.



Back View Large Size 4 x 8

The Clear Vision Stereoscopic Box has been designed and built optically correct to eliminate the front surface reflection of the glass when silvered upon its rear surface.

This has been scientifically accomplished by using mirrors silvered on the front or first surface of the glass. To protect these sensitive mirrors from dust, objects and oxidizing agents, they have a dust-proof enclosure of clear non-refracting ophthalmic glass placed in a position where it cannot give any reflection of the radiograph to the observer's eyes.

The first surface reflection of the radiograph fogs and blurs the second surface reflection of the radiograph from 5 to 15 per cent. Obviously the increased visual acuity of the radiograph equals the elimination of the fogging and blurring because of the increased accuracy in relief and detail in making deductions of position, shape, size and pathology.

The questions of those who have inspected or are using the Clear Vision Stereoscopic Box may be summarized thus: 1. Are the radiographs clearer with the elimination of the first surface reflection? 2. What is the life of the mirrors? 3. What is their commercial value? The first has a positive answer. The second—We have every assurance from experimental tests, that mirrors thus protected will last for many years. The third—Multiply the cost of your diagnostic *x*-ray laboratory by the percentage of your increased diagnostic efficiency.

Verify the accuracy of these statements by a little observation on: The landscape mirrored in a lake is a first surface reflection; also traffic reflected in a street window. This is easily demonstrated by the critical roentgenologist with any object viewed in a stereoscopic mirror at an angle of 45 degrees.

REAVES INSTRUMENT SHOP

BOX 1494 : : : GREENSBORO, N. C.

Makers of

PERISCOPIC HEAD LIGHT - UNIVERSAL RHEOSTAT - ANATOMICAL RECORD CARD

Founded in 1906
AS THE AMERICAN QUARTERLY
OF ROENTGENOLOGY

Official Organ of
THE AMERICAN ROENTGEN RAY SOCIETY
& THE AMERICAN RADIUM SOCIETY

THE AMERICAN JOURNAL OF
ROENTGENOLOGY & RADIUM THERAPY
PUBLISHED MONTHLY BY PAUL B. HOEBER, INC.
SIXTY-SEVEN AND SIXTY-NINE EAST FIFTY-NINTH STREET
NEW YORK CITY

IMPORTANT NOTICE

Subscribers will have noticed the increase in size of THE AMERICAN JOURNAL OF ROENTGENOLOGY & RADIUM THERAPY during the past few years. Vol. 1, 1914, contained 495 pages, Vol. IX, 1922, 856 pages, and the volume for 1923 will be even larger. Despite this the editors have had to exclude much splendid material in order to keep within bounds.

There is no necessity to explain the increase in costs since 1914 and we may point with pride to the fact that despite this increase, which ran parallel with the doubling in size of the Journal, the subscription price has been raised only $1.00, from $5.00 to $6.00. This was made possible only by the support given the Journal by The American Roentgen Ray Society.

Dr. Arthur C. Christie of Washington, D.C., is to be editor beginning January 1924. The plans for next year call for a Journal of at least 1200 pages, divided into two volumes, with an index in July as well as in December. While it is realized that the Journal is recognized today as the leading x-ray journal in the world, those in charge still feel that further improvements are possible and that our readers are entitled to the very best that can possibly be attained. Arrangements have been made for a complete abstract department, more illustrations, and further improvements in every department. The editorial policy will be a vigorous one and it is expected that THE AMERICAN JOURNAL OF ROENTGENOLOGY & RADIUM THERAPY will cover every branch of the subjects named in its title.

After mature deliberation, it has been decided that to do justice to the Journal and to its readers, the subscription price from January 1924 will be $10.00 per year. Be it remembered that similiar foreign journals giving less material have charged this price for some time.

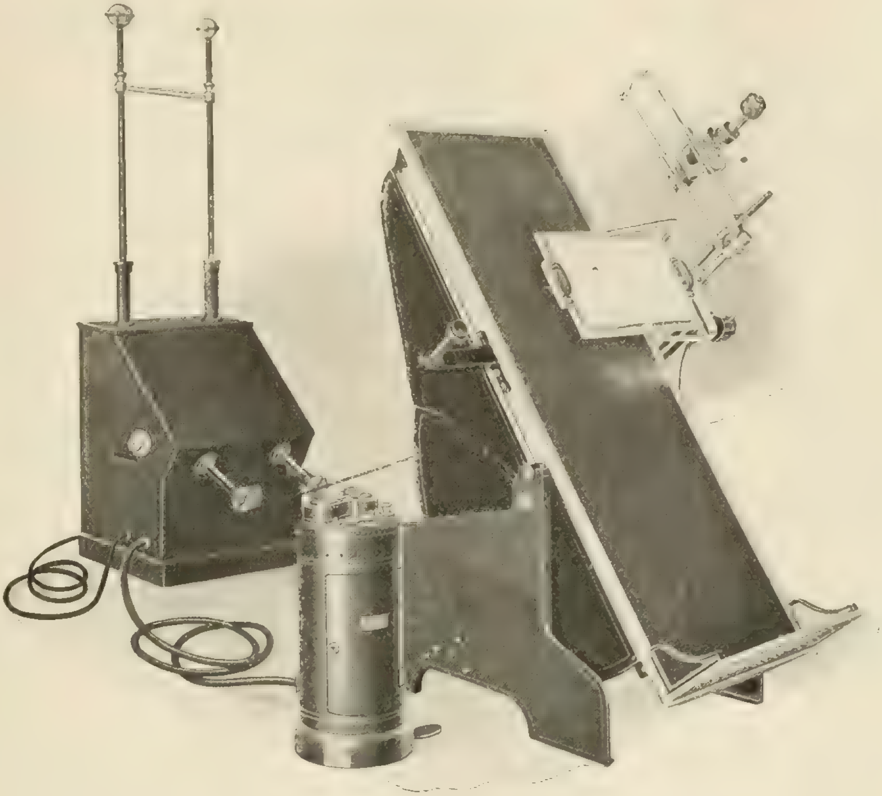
Present subscribers, whose subscriptions expire with the October, November or December 1923 issues, may if they remit promptly, renew their subscriptions until the end of 1924 by the payment of only $10.00, giving them the last three numbers of this year free--fifteen numbers for the price of twelve.

It is hoped that our readers will understand that a special journal of this kind is dependent on subscribers for its support. It is expected that everyone will realize that the additional charge is for nothing except increased services rendered and it must be remembered that at the $10.00 price the improved journal will be even more reasonable than it has been in the past. We, therefore, bespeak the support of all our subscribers and their assistance in increasing the scope, influence and possibilities of the Journal by recommending it to others.

Respectfully,

PAUL B. HOEBER, INC.,

Publishers.



THE DUPLEXRAY IDEALS

We are in a position to help each other farther than ever before toward the fulfillment of our ideals.

Yours—to more completely lighten the sufferings of mankind, to make your range of treatment more extensive, and to bring to yourself that additional confidence and respect as well as financial gain which is accorded to the famous Roentgenologist.

Ours—to offer to the profession the most perfect Equipment which it is humanly possible to produce, one which will be continuously Reliable and Dependable in Operation, one which will return the most satisfactory results for the least operating time and effort, one which is compact and economical in the use of costly office space.

The DupleXray with the Kelley-Koett Motor Driven Tilt Table is our suggestion for the smaller laboratories. The DupleXray is an efficient X-Ray Plant for Radiography and Fluoroscopy.

We would like to send you more complete imformation about this Equipment.

THE ENGELN ELECTRIC COMPANY

2808 Superior Avenue Cleveland, Ohio

GENERAL INFORMATION

Original articles are published only with the understanding that they are contributed exclusively to this Journal. Manuscripts offered for publication and other correspondence relating to the editorial management and books for review should be sent to Dr. H. M. Imboden, Editor, 480 Park Avenue, New York, N. Y. Contributions may be sent in foreign languages and will be translated if found acceptable.

A certain number of illustrations will be supplied free of cost; but special arrangements must be made with the editor and publisher for excess illustrations and elaborate tables. Drawings and charts for reproduction should be made in black (*never* in blue) when intended for reproduction. Photographic prints of plates or slides on glossy paper produce the best half-tones.

Manuscripts should be typewritten, in double spacing, with good margins (not on thin paper) and the original sent us; it is a good plan for the author to keep a carbon copy, as used manuscripts are not returned. All photographs and drawings should be numbered, and accompanied by legends with corresponding numbers. The top should be indicated on the photograph.

The author should always place his *full address* somewhere on his manuscript. This is very important, and is often omitted.

Reprints are furnished on order only and should be ordered of the publisher when galley proofs are submitted. Prices will be quoted on request.

All correspondence regarding subscriptions, advertisements and other business of The American Journal of Roentgenology and Radium Therapy should be addressed to the Publisher, Paul B. Hoeber, 67–69 East 59th Street, New York.

For information about membership in The American Roentgen Ray Society address the Chairman of the Executive Council, Dr. W. B. Bowman, Los Angeles, Cal.

For information regarding program of annual meeting, address the President-Elect, Dr. H. E. Potter, 122 S. Michigan Ave., Chicago.

In sending change of address, the old as well as the new address must be given.

In corresponding with the publisher about more than one subject, reprints, subscriptions, meetings, etc., please put each item on a separate sheet. Please make all communications containing orders, requests, information or directions as specific as possible.

A TIMELY MONOGRAPH · JUST PUBLISHED

DIATHERMY AND ITS APPLICATION TO PNEUMONIA

By HARRY EATON STEWART, M.D., Attending Specialist in Physiotherapy, U. S. Marine Hospitals, N. Y.; Director, New Haven School of Physiotherapy; Formerly Asst. Director, Section of Physiotherapy, Office of Surgeon General, U. S. A.; Supervisor Physiotherapy, U. S. P. H. S., Washington.

Synopsis of Contents: Preface; Introduction; General Diathermy Technique; Surgical Diathermy; Detailed Case Reports; Summary of Total Case Reports; Bronchopneumonia; Conclusions; Index.

"Particular emphasis is laid on the fact that diathermy properly applied is harmless under all conditions and that it brings almost invariable symptomatic relief. Above all *it has apparently lowered the general average mortality.* This lessened death rate was particularly evident in a carefully worked out comparison with a group of controls under conditions identical in every respect, except in the use of diathermy."

12MO, CLOTH, 228 PAGES WITH 45 ILLUSTRATIONS AND 15 CHARTS · $3.00 *Net*

Published by PAUL B. HOEBER, Inc., 67-69 E. 59th St., N. Y.

Publishers of The American Journal of Roentgenology & Radium Therapy

THE AMERICAN ROENTGEN RAY SOCIETY
AND THE AMERICAN RADIUM SOCIETY
Officers and Standing Committees

THE AMERICAN ROENTGEN RAY SOCIETY

President: H. E. Potter, M.D., 122 S. Michigan Ave., Chicago, Ill.
President-Elect: G. W. Holmes, M.D., 205 Charles St., Boston, Mass.

First Vice-President
F. M. Law, M.D., 576 Fifth Ave., New York, N. Y.

Second Vice-President
E. C. Samuel, M.D., New Orleans, La.

Secretary
W. W. Watkins, M.D., Phoenix, Ariz.

Treasurer
W. A. Evans, M.D., 32 Adams Ave. W., Detroit, Mich.

Librarian and Historian: H. W. Dachtler, 224 Michigan St., Toledo, O.

Executive Council
W. F. Manges, M.D., Chairman, Philadelphia, Pa.
A. H. Pirie, M.D., Montreal, Canada
H. M. Imboden, M.D., New York City
H. E. Potter, M.D., Chicago, Ill.
G. W. Holmes, M.D., Boston, Mass.
W. W. Watkins, M.D., Phoenix, Ariz.
W. A. Evans, M.D., Detroit, Mich.
T. A. Groover, M.D., Washington, D. C.
E. C. Ernst, M.D., St. Louis, Mo.
M. P. Burnham, M.D., San Francisco, Calif.

Committee on Laws and Public Policy
A. C. Christie, M.D., Chairman, Washington, D. C.
D. Y. Keith, M.D., Louisville, Ky.
D. R. Bowen, M.D., Philadelphia, Pa.

Safety Committee
G. W. Holmes, M.D., Chairman, Boston, Mass.
P. M. Hickey, M.D., Ann Arbor, Mich.
W. D. Coolidge, PH.D., Schenectady, N. Y.
H. K. Pancoast, M.D., Philadelphia, Pa.
William Duane, PH.D., Boston, Mass.
Bernard H. Nichols, M.D., Cleveland, O.

Leonard Prize Committee
George E. Pfahler, M.D., Philadelphia, Pa.
Frederick H. Baetjer, M.D., Baltimore, Md.
George W. Holmes, M.D., Boston, Mass.

Publication Committee
W. F. Manges, M.D., Philadelphia, Pa.
H. E. Potter, M.D., Chicago, Ill.
W. W. Watkins, M.D., Phoenix, Ariz.

Member of the National Research Council
P. M. Hickey, M.D., Ann Arbor, Mich.

Editor: H. M. Imboden, M.D., 480 Park Ave., New York City
Associate Editors: James T. Case, M.D., H. K. Pancoast, M.D., William Duane, PH.D.
Charles Eastmond, M.D., D. Y. Keith, M.D., Roy A. Payne, M.D.
Publisher: Paul B. Hoeber, 67–69 East 59th Street, New York City

TWENTY-FIFTH ANNUAL MEETING
To be announced

SECTIONS OF THE AMERICAN ROENTGEN RAY SOCIETY

EASTERN SECTION

Chairman
Thomas A. Groover, M.D.,
Washington, D. C.
Vice-Chairman
Charles Eastmond, M.D.,
Brooklyn, N. Y.
Secretary
William C. Wescott, M.D.,
Atlantic City, N. J.
Fifth Annual Meeting
Atlantic City, N. J., Jan. 24–26, 1924.

CENTRAL SECTION

Chairman
D. Y. Keith, M.D., Louisville, Ky
First Vice-Chairman
W. O. Upson, M. D., Battle Creek, Mich.
Second Vice-Chairman
Charles Goosman, M.D., Cincinnati, O.
Secretary
R. C. Beeler, M.D., Indianapolis, Ind.
Fifth Annual Meeting
Indianapolis, Ind., Feb. 23, 1924.

PACIFIC SECTION

Chairman
M. P. Burnham, M.D.,
San Francisco, Calif.
Vice-Chairman
F. C. Swearingen, M.D.,
Pomona, Calif.
Secretary
Roy A. Payne, M.D., Portland, Ore.
Fourth Annual Meeting
To be announced

THE AMERICAN RADIUM SOCIETY

President: James T. Case, M.D., Battle Creek Sanitarium, Battle Creek, Mich.
President-Elect: William S. Newcomet, M.D., 3501 Baring St., Philadelphia, Pa.

First Vice-President
Harry H. Bowing, M.D., Rochester, Minn.

Second Vice-President
Douglas Quick, M.D., New York City

Secretary
Edwin C. Ernst, MD., St. Louis, Mo.

Treasurer
Robert E. Loucks, M.D., Detroit, Mich.

Executive Committee
Henry K. Pancoast, M.D., Chairman, Philadelphia
Henry Schmitz, M.D., Chicago, Ill.
George E. Pfahler, M.D., Philadelphia

Program Committee
Henry Schmitz, M.D., Chairman, Chicago, Ill.
E. C. Samuels, M.D., New Orleans, La.
C. F. Burnam, M.D., Baltimore, Md.

Membership Committee
Douglas Quick, M. D., Chairman New York City
H. N. Cole, M. D., Cleveland, Ohio
Sanford B. Withers, M. D., Denver, Colorado

Arrangement Committee
Howard Morrow, M.D., Chairman, San Francisco
William Montgomery, M.D., San Francisco
Lawrence Taussig, M.D., San Francisco

NINTH ANNUAL MEETING
To be announced

Announcing

ACME-INTERNATIONAL

X. R. V.

PLATE-CHANGER

Any standard
14 x 17 or 11 x 14
cassette used

Angular or vertical
adjustment

Vibration practically
eliminated

Extra rapid
shifting mechanism

Cassettes
inserted or ejected
without resetting

Minimum space
between
film and patient

FAST NOISELESS RIGID

Illustrated descriptive bulletin furnished on request

ACME-INTERNATIONAL X-RAY CO.

341 WEST CHICAGO AVE. CHICAGO, ILLINOIS

Service and distributing headquarters in all localities

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]
OFFICIAL ORGAN OF
THE AMERICAN ROENTGEN RAY SOCIETY
AND THE AMERICAN RADIUM SOCIETY

VOL. X DECEMBER, 1923 NO. 12

CONTENTS

PAGE

Ionization Methods of Measuring X-Ray Dosage. 935
BY WILLIAM DUANE, PH.D., SC.D.

The Economics of Dosimetry in Radiotherapy 944
BY GIOACCHINO FAILLA, E.E., AND EDITH H. QUIMBY, M.A.

Studies on the Biological Effects of X-Rays 968
BY JAMES W. MAVOR

The Occurrence of Two Heritable Types of Abnormality Among the Descendants of X-Rayed Mice 975
BY C. C. LITTLE, SC.D., AND H. J. BAGG, PH.D.

Forceps for Cleaning Radium Needles and Tubes. 989
BY J. S. ULLMAN, M.D.

Editorials. 990

Book Reviews. 992

Translations and Abstracts 993

Index 1021

The American Journal of Roentgenology and Radium Therapy is maintained by, and in the interests of The American Roentgen Ray Society, and published monthly by Paul B. Hoeber, 67-69 East 59th Street, New York, N. Y.

The American Journal of Roentgenology and Radium Therapy does not hold itself responsible for any statements made or opinions expressed by any contributor in any article published in its columns.

The subscription price of The American Journal of Roentgenology and Radium Therapy is $6.00 per year, in advance, in the United States, $6.50 in Canada, and $7.00 in other foreign countries. Current single numbers $1.00. Prices for back numbers will be quoted on request.

General information will be found on page vi.

Entered as second-class matter, March 3, 1916, at the Post Office, New York, N. Y., under the Act of March 3, 1879.

Copyright, 1923, by Paul B. Hoeber

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized August 5, 1919.

Deep Therapy With the "Snook Special"

A criterion which is obviously acceptable to the roentgenologist who contemplates an installation for deep X-Ray therapy, is a representative list of users of a given make of apparatus.

The Victor Model "Snook Special" Combination Deep Therapy-Diagnostic Roentgen Apparatus is proving its merits in many large hospitals and specialized laboratories in this country. Herewith is a partial list of users:

Crossett Hospital, Crossett, Ark.
Dr. L. C. Kinney, San Diego, Calif.
Soldiers Home, Sawtelle, Calif.
Bridgeport City Hospital, Bridgeport, Conn.
Dr. W. F. Jenkins, Columbus, Ga.
St. Alphonsus Hospital, Boise, Idaho
St. Mary's Hospital, Decatur, Ill.
St. John's Hospital, Springfield, Ill.
St. Francis Hospital, Blue Island, Ill.
West Suburban Hospital, Oak Park, Ill.
Dr. Harold Swanberg, Quincy, Ill.
Physicians' Laboratory, Ft. Wayne, Ind.
Dr. C. C. Grandy, Ft. Wayne, Ind.
St. Luke's Hospital, Richmond, Ind.
Dr. R. F. Bellaire, Sioux City, Iowa
Dr. O. W. Wyatt, Manning, Iowa
Dr. J. W. Rowntree, Waterloo, Iowa
Council Bluffs Clinic, Council Bluffs, Ia.
Dr. L. G. Allen, Kansas City, Kans.
Methodist Hospital, Goodland, Kans.
Dr. Allen Donaldson, Carrollton, Ky.
Dr. H. G. F. Edwards, Lafayette, La.
Dr. S. O. McKinney, Lake Charles, La.
Dr. T. E. Hardy, Waterville, Me.
Dr. J. W. Pierson, Baltimore, Md.
Huntington Memorial Hospital, Brookline, Mass.
Blodgett Memorial Hospital, Grand Rapids, Mich.
Winona General Hospital, Winona, Minn.
Dr. J. M. Willis, McCook, Nebr.
Dr. L. W. Rork, Hastings, Nebr.
Dr. W. A. Schmitz, Middletown, N. Y.
Dr. J. E. Stewart, Akron, Ohio
Dr. Thos. McElroy, Ponca City, Okla.
St. Anthony's Hospital, Oklahoma City, Okla.
Multnomah Co. Hospital, Portland, Ore.
Dr. F. A. Sherrer, Easton, Pa.
Dr. G. C. Bird, Philadelphia, Pa.
Stetson Hospital, Philadelphia, Pa.
Dr. L. W. Kuser, Gainesville, Tex.
Mountain State Hospital, Charleston, W. Va.
St. Mary's Hospital, Racine, Wis.
Dr. W. H. McGuffin, Calgary, Alta., Can.
Dr. J. C. McMillan, Winnipeg, Man., Can.
General Public Hospital, St. John, N. B., Canada
Dr. W. A. Wilkins, Montreal, Que., Can.
Dr. C. M. Henry, Regina, Sask., Can.

We feel sure that any of these users will be willing to tell you frankly what they have realized in their operation of the "Snook Special," both electrically and mechanically; also regarding the Victor Personalized Service which co-operates so effectively toward maintaining the high efficiency of this Victor apparatus. Every roentgenologist appreciates the advantage in working with a machine that is delivering consistently.

Our extensive experience in the design, manufacture and installation of Deep Therapy Apparatus will mean much to you. Let us advise with you

VICTOR X-RAY CORPORATION, 236 South Robey Street, Chicago, Ill.
Sales Offices and Service Stations in All Principal Cities

VICTOR

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X DECEMBER, 1923 No. 12

IONIZATION METHODS OF MEASURING X-RAY DOSAGE*

BY WILLIAM DUANE, PH.D., SC.D.

Harvard University

BOSTON, MASS

IN this paper and those to which it refers are described methods of measuring *x*-ray dosage by means of ionization currents. The methods have the advantage of measuring, not the power or current put into the tube, plus the voltage, filtration, focal distance, etc., but something associated with the actual beam of *x*-rays employed. They measure what may be defined to be the intensity and the effective wave-length of the *x*-ray beam in terms of certain absolute units, so that the measurements may be compared with similar ones made in other laboratories and clinics.

The methods have a further advantage in that the deflection of the instrument as read on a scale gives the value at each instant of time of the intensity of the *x*-radiation at the place where the detecting instrument lies. It is thus possible to determine at any time during a treatment the intensity of the *x*-radiation entering the patient's skin or emerging again on the other side of the body. Further, the instrument may be used to determine the percentage of radiation coming through a filter of any substance or thickness, the amount of scattered radiation coming from a patient or from the filter in different positions, etc., etc.

The paper contains a few illustrations of the many possible applications of these methods. A series of experiments are described illustrating the measurement of depth doses in water-phantoms. Measurements of the intensity of the *x*-ray beam at points at different distances from the surface of the phantoms along the axis of the beam will be given. By means of the isodose charts, the intensity at any point in the phantom can be determined. Such charts should be mapped out for each particular kind of *x*-ray plant employed, and also with varying volumes of water, so as to reproduce as nearly as possible the conditions obtaining in the actual treatments of patients. The measuring instrument described below enables one to do this with reasonable precision. As these charts give only a rough estimate of the intensity of the radiation itself, at points in the body of a patient, and as so many of them have already been published in recent literature, it does not seem necessary to reproduce similar ones here.

The paper concludes with a brief account of some experiments carried on in our own laboratory on the wave-lengths (and therefore the penetrating powers) of *x*-rays scattered by various substances. The problem of scattered radiation has become one of great importance, not only from the point of view of the patient but also from that of the operator himself. Our careful measurements with an accurate *x*-ray spectrometer have revealed the fact that scattered radiation contains a large number of rays that are just as short, and therefore just as penetrating, as the primary rays.

---

* The author of this paper was awarded first prize, $500.00, in the Leonard Prize contest.

The ionization effect of *x*-rays forms the basis of the methods of measurement described in this paper.

In February, 1896, Sir Joseph Thompson announced the discovery of the fact that the *x*-rays observed the year before by Roentgen, when they pass through a gas, make of it a conductor of electricity. Benoist and Harmozescu in France and Righi in Italy observed the same phenomenon at about the same time. According to the researches made since the discovery of this phenomenon, the *x*-rays split up molecules of the gas into charged particles, some of which carry positive, and others negative charges. The motion of these charged particles or ions, as they are called, through the other molecules of the gas, carries the electricity through it and thus produces the conductivity. From the name of the charged particles—ions—we call this phenomenon the ionization of a gas.

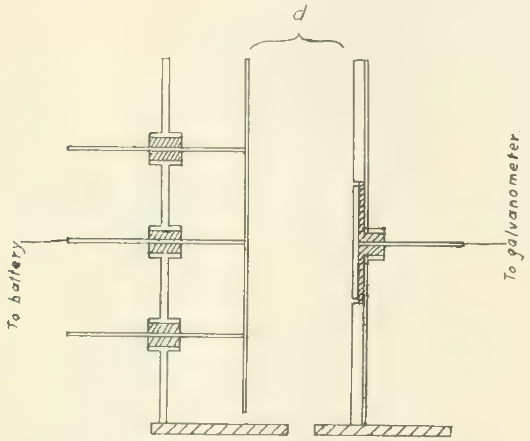


Fig. 1. Standard ionization chamber with variable distance between plates.

In modern physics we usually define the intensity of a beam of rays to be the amount of energy carried per second through a square centimeter of a surface imagined to be drawn across the rays perpendicular to them. In the case of *x*-rays we can measure the amount of energy carried by absorbing the rays and estimating the rise in temperature of the material that absorbs them. In order to do this, however, we require exceedingly delicate apparatus and great skill in experimentation. A method of estimating the intensity of *x*-rays by means of their heating effect does not seem, therefore, to be a practical method of estimating dosage for every-day use, and we are forced to employ, as a means of determining their intensity, some other effect produced by the rays. At present, the ionization effect appears by far the best. It may not be out of place to mention that an ionization current depends upon the amount of radiant energy *absorbed* by the gas. This is an advantage, for it is the energy absorbed by the tissues that produces the effect in therapy.

The ionization methods of measuring *x*-ray dosage here referred to have already been described at some length in THE AMERICAN JOURNAL OF ROENTGENOLOGY (Dec., 1922, p. 781, and May, 1923, p. 399). We will, therefore, refer the reader to these previous publications for details.

In using a standard ionization chamber to calibrate other chambers, care must be taken to include practically all the ionization effects of the *x*-rays.

In order to determine experimentally how far apart the plates must be in order to include practically the whole amount of ionization produced by the *x*-ray beam, I designed the standard ionization chamber represented in Figure 1. The plate attached to the battery is movable and can be shifted so as to vary the distance, *d*, between it and the plate joined to the galvanometer. The lead end of the ionization chamber was not attached to the rest of the instrument so that the hole in it could be shifted in such a way as to allow the beam of *x*-rays to pass always halfway between the plates.

The following table contains the deflections of the galvanometer with the plates placed at different distances apart when this ionization chamber was used in the electrical circuit.

Distances between plates *d* (cm.)	Deflection of galvanometer (mm.)
2.2	28.2
3	29.2
4	30.6
5	30.8
6	30.4
7	30.6

In this experiment the constant voltage applied to the tube amounted to about

200,000 volts and the effective wave-length was .15 Ångström.

It appears from the data contained in the table that no increase in ionization current occurs if the distance between the plates is increased beyond about 4 cm. Hence a distance of 4 or 5 cm. between the plates suffices to include the effects of substantially all of the secondary radiation within the limit of error of the measurements.

In order to measure currents a galvanometer must be calibrated. The calibration consists in sending a known current through the instrument and reading its deflection. The best method of obtaining a known small current such as those employed in *x*-ray dosage measurements is to use a standard cell joined to standard resistances. The standard cell and resistances are fastened in a box and the circuits joined electrically to the galvanometer. A plug contact in the box enables one to send the standard current through the instrument at any desired time. It is convenient to have the standard resistances so chosen as to send a current through the galvanometer equal to that which would be produced in the ionization chamber one is using, if the ionization chamber lay in an *x*-ray beam of one-tenth of a unit. With such an arrangement of circuits all that is necessary in order to measure the intensity of the *x*-ray beam in absolute units is to read the deflection due to the ionization chamber and also that due to the standard cell. Then divide the former by the latter and multiply the quotient by one-tenth. The result is the intensity of the *x*-ray beam in the absolute electrostatic units. These I have called E units.

It is perhaps superfluous to call attention to the fact that in estimating dosage—erythema dose, for instance—it is necessary to measure the effective wave-length of the beam as well as its intensity, for the amount of *x*-ray energy absorbed by the tissues depends upon the wave-length.

These wave-length measurements may be made with either a standard ionization chamber or one of the smaller chambers. It is sometimes advisable to standardize the smaller chamber for wave-length measurements as well as for intensity measurements, by comparison with the standard ionization chamber. If, however, the plates in the chamber are carbon, the wave-length calibration does not appear to be necessary.

The methods of estimating the *effective* wave-length of an *x*-ray beam I described in The American Journal of Roentgenology for March, 1922, on pages 170 and 171, and also for December, 1922, on pages 788 and 789. It consists in measuring (by means of an ionization chamber, for instance) the fraction of *x*-radiation that passes through a sheet of copper of given thickness. From this fraction the effective wave-length may be read off by means of a curve which represents the fractions of *x*-rays of different wave-lengths that pass through the plate, the wave-lengths having been measured by means of an *x*-ray spectrometer. For details of the methods the reader is referred to the above-mentioned papers.

One important feature of this method lies in the fact that the reading of the galvanometer gives, not the total dose received by the patient, but the intensity of the *x*-ray beam at a given instant of time. In order to get the total dose we must multiply the intensity by the time of exposure.

It is important to determine and record both the intensity factor and the time factor of *x*-ray doses; for many effects produced by the rays are not proportional simply to the product of the two factors. It seems likely from some recent estimates of erythema dose made by means of these ionization chambers that the erythema produced in the skin by *x*-rays is not always proportional to the product of the intensity by the time of exposure. Some of our recent estimates of erythema indicate that if one reduces the intensity to one-half its value the time required to produce an erythema must be more than double.

The large, standard ionization chambers are not suitable for measurements of the intensity of the *x*-rays received by the patient during a treatment. We invariably use one of the small ionization chambers for this purpose. We measure the intensity of the rays at the surface where they enter the patient's body, and also where they emerge. This gives us an estimate of the secondary radiation coming from the patient's body. The estimate, however, is too low. Estimates may be made by means of water-phantoms, placing the small ionization chamber in the water itself. This estimate is always too high. The real dose received by the patient's skin lies between the two. We have obtained quite variable estimates of the secondary radiation from different patients made by measurements taken during the treatments themselves. The secondary radiation appears to depend not only upon the size of the portal of entry, but also upon the size of the patient and the shape, content, etc., of the portion of the body radiated. In estimating erythema doses all these factors must be taken into consideration. The safest method is to make the measurements while the patient is actually being treated.

In many of the ionization methods of measuring dosage one determines the ionization current by timing with a stop watch the passage of the leaf of an electroscope across a scale. In methods of this kind some difficulty often arises in determining whether the current is saturated or not. Very particular attention should be paid to this point. Other sources of error in such measurements are mentioned on pages 404 and 405 of The American Journal of Roentgenology and Radium Therapy, for May, 1923.

As illustrations of this method, let us consider the following problems: Firstly, to measure the intensity and effective wave-length of an *x*-ray beam by means of one of the standard ionization chambers. The apparatus having been set up, the closing of the standard cell circuit produced a deflection of 24.5 mm. The ionization current due to the *x*-ray beam passing through the standard ionization chamber produced an average deflection of 16.1 mm. On adding a sheet of copper having an average thickness of .50 mm. the deflection due to the *x*-rays passing through the standard ionization chamber fell to 10.4 mm. The standard cell produced a current of 5 e.s.u. through the galvanometer. The volume of air in the standard ionization chamber from which the ions came to the plate connected with the galvanometer was 25 cm. Hence, an *x*-ray beam producing the same deflection as that due to the standard cell current would have an intensity of 5 divided by 25, in other words, of 0.2E. To get the actual intensity of the *x*-ray beam we therefore divide 16.1 by 24.5 and multiply the quotient by 0.2. This gives 0.131E as the intensity of the *x*-ray beam expressed in these absolute electrostatic units, the E units.

To get the effective wave-length we divide the deflection after ½ mm. of copper has been added to the filter, namely, 10.4, by the deflection before it was added, namely, 16.1. This gives 0.645. In other words, the radiation coming through the one-half mm. of copper amounts to 64.5 per cent. Referring to the curve representing the fractions of the radiation of different wave-lengths getting through the one-half mm. of copper, we find that the effective wave-length is about 0.164.

The intensity and effective wave-length of an *x*-ray beam depend to a considerable extent upon the type of generator employed and the way in which it happens to be running, even though the voltage, as estimated by a sphere-gap, the current through the tube, the filtration and distance from the tube, may be given. It is impossible, therefore, to state accurately what the intensity and effective wave-length of a beam may be under the above-given conditions. Actual measurements have shown, however, that the intensities of *x*-ray beams 50 cm. from the tube after they have passed through 2 or 3 mm. of aluminum and with voltages of 80,000 to 100,000 volts, and currents through the tubes of 3 to 5 ma. range in the region of intensities between 0.1 and 0.5 e.s.u.

The *x*-rays from a tube running at a voltage in the neighborhood of 200,000 volts with 3 or 4 ma. passing through the tube and with a filter of ½ to 1 mm. of copper, have intensities ranging from 0.1 to 0.2 at a distance of 50 cm. from the target. Certain types of commercial machines, however, produce similar intensities only when running at 230,000 to 240,000 volts.

The effective wave-lengths of the *x*-rays after they have passed through 2 or 3 mm. of aluminum lie between 0.4 and 0.5°

Ångströms, if the voltage applied to the tube lies between 30,000 and 40,000 volts. For voltages between 80,000 and 100,000, and with filtration of 3 to 4 mm. aluminum, the effective wave-lengths lie between 0.2 and 0.3° Ångströms. If the voltage be raised to 200,000 volts or thereabouts, the *x*-rays coming through a filter of ½ to 1 mm. of copper have wave-lengths lying in the range from 0.14 to 0.17 Ångströms. These wave-lengths are somewhat shorter than those of the characteristic *x*-rays of the tungsten target (namely, .184, .209 and .213). Their exact positions with reference to the tungsten line spectrum may be seen by referring to the above-mentioned articles in THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY.

The effective (or average) wave-length should not be confused with the shortest wave-length in the spectrum, which is always given by the relation $V\lambda = 12{,}350$, where V represents the maximum voltage applied to the tube.[1]

In order to calibrate one of the small ionization chambers by means of a standard ionization chamber, we need only to measure the same beams of *x*-rays with each of them. The ratio of the galvanometer's deflection with the small chamber to that with the standard chamber gives us a certain factor, which, if the chambers are properly constructed, is substantially the same over a certain range of wave-lengths. This range may be considerably increased by using graphited paper as electrodes in the chamber. We may employ the factor in calculating the intensities of the *x*-ray beams. A more convenient method, however, consists in changing the resistances in the standard cell box so as to increase the current it sends through the galvanometer in the same ratio. The quotient found by dividing the deflection due to the ionization current by that due to the standard cell may then be used in exactly the same way as in the case of the standard ionization chamber.

As an illustration of one of the uses to which these ionization chambers may be put, let us consider the problem of determining the depth dose of *x*-rays passing through a water phantom.

When the ionization chamber lies in the water a great deal of radiation passing through it comes as scattered or secondary radiation from the water surrounding it. The secondary radiation passes through the chamber in all directions, and in order to record the effects due to this secondary radiation it is desirable to have an ionization chamber such that similar rays passing through it in different directions produce at least approximately the same ionization current.

An ionization chamber similar to that represented in Figure 2, D, has been designed for depth-dose measurements in water-phantoms.[1] It consists of a thin, hard rubber box, sealed up tight and covered with a thin rubber bag, so that the water cannot penetrate it. The electrodes consist of thin plates and may be of aluminum or of paper covered with pencil marks. A wire passing through and insulated from a small lead tube connects two of the plates to a battery, and another wire, similarly insulated and protected, connects the third, central plate to a galvanometer. The insulation and lead shielding of these connecting wires are made quite small so as not to absorb any more than necessary of the radiation that would pass through the ionization chamber coming from the water in their neighborhood.

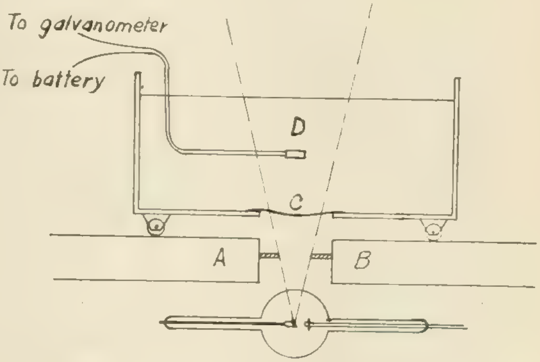


FIG. 2. Water-phantom for depth-dose measurements.

Special experiments have shown that for an ionization chamber constructed in this way the current due to rays passing through it in various directions does not lie more than 4 per cent, on the average, below that due to rays passing straight through it.

---

[1] DUANE and HUNT. *Phys. Rev.*, Aug., 1915, p. 166.

[1] AM. J. ROENTGENOL. & RAD. TH., May, 1923, p. 399.

Figure 2 represents the water-phantom used for this experiment. It consists of a wooden box (30 × 14 × 14 in.) on rollers, that can be moved over the opening in the floor, AB, through which the *x*-rays come from a tube in the room below. A sheet of rubber, C, 2 mm. thick, covers the opening in the bottom of the box. The water in the box causes this rubber covering to sag slightly and to take more or less the form of the human body. The rubber may be taken to represent the skin of a patient.

The calibration of this ionization chamber indicated that if the deflection obtained was the same as that due to the standard cell which produced a current of 5 electrostatic units, the intensity of the radiation passing through the chamber would be 1/10th of an electrostatic unit of radiation (E unit).

The standard cell gave a deflection of 33.3.

Without the water-phantom the ionization chamber placed at the level where the rubber would be gave a deflection of 23.4 mm.

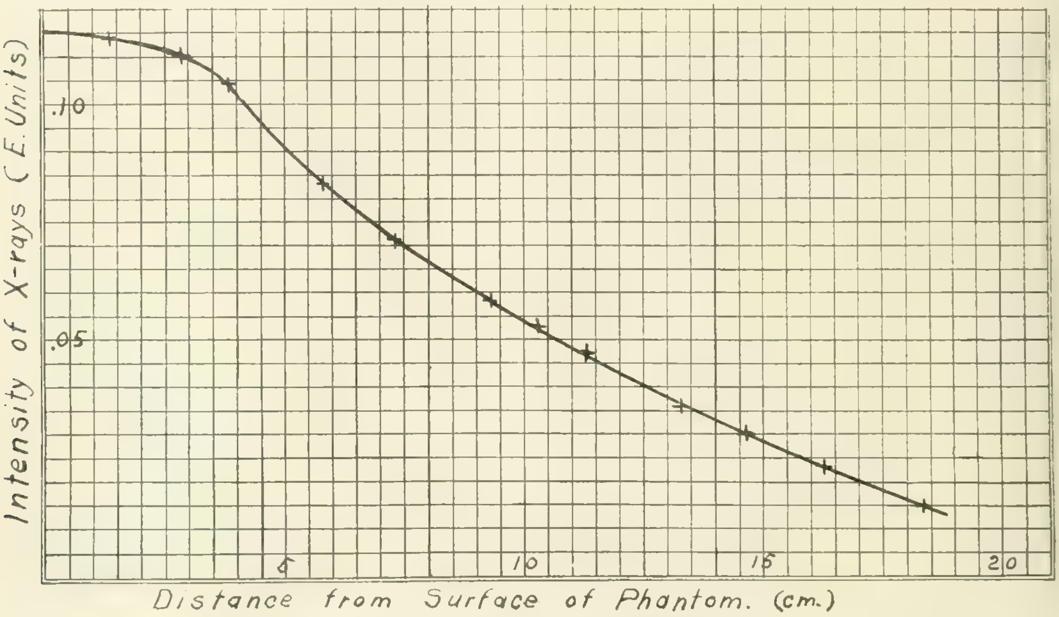


FIG. 3. Curve showing depth doses in a water-phantom.

The lead-covered wires leading to the ionization chamber, D, support it in any desired position in the water. In one experiment with this apparatus the following data has been obtained:

Current through *x*-ray tube—3 ma.

Rough estimate of voltage by sphere-gap—175 kv.

Effective wave-length measured by fraction of radiation passing through ½ mm. copper—0.16.

Distance from target to water-phantom—85 cm.

Depth of water—19.2 cm.

Portal of entry—20 × 20 cm.

The ionization chamber just below the rubber of the water-phantom gave a deflection of 34.5 mm. and the ionization chamber above the water in the phantom gave a deflection of 2.5 mm.

Thus, the intensity at the level where the rubber would be was $\frac{23.4}{33.3} \times 0.1 = 0.070\text{E}$ without the water-phantom.

On putting the water-phantom in place, the intensity rose to $\frac{34.5}{33.3} \times .1 = 0.104\text{E}$, representing an increase in intensity of about 49 per cent. This increase came from the secondary radiation produced in the phantom.

The intensity just above the water in the phantom amounted to $\frac{2.5}{33.3} \times .1 = 0.0075\text{E}$, that is, approximately 7.3 per cent of that just below the phantom.

The following table contains the deflections and intensities of *x*-radiation at different distances above the under-surface of the rubber sheet:

Distances (cm.)	Deflection (mm.)	Intensity (E units)
1.3	38.0	.114
2.8	37.0	.111
3.8	34.5	.104
5.8	27.6	.083
7.3	23.5	.071
9.3	19.3	.058
10.3	17.5	.053
11.3	15.5	.047
13.3	12.0	.036
14.6	10.0	.030
16.3	7.8	.023
18.3	5.0	.015

The curve in Figure 3 has been drawn from the data of the above table and represents the decrease in intensity of *x*-rays on passing upward through the water in the phantom. It will be seen from the curve that the intensity at the surface of the rubber amounts to about 0.116E and at 10 cm. above the surface to about 0.054E. The percentage depth dose amounts, therefore, to 47 per cent at a depth of 10 cm. The curve is nearly horizontal for some distance above the surface of the phantom.

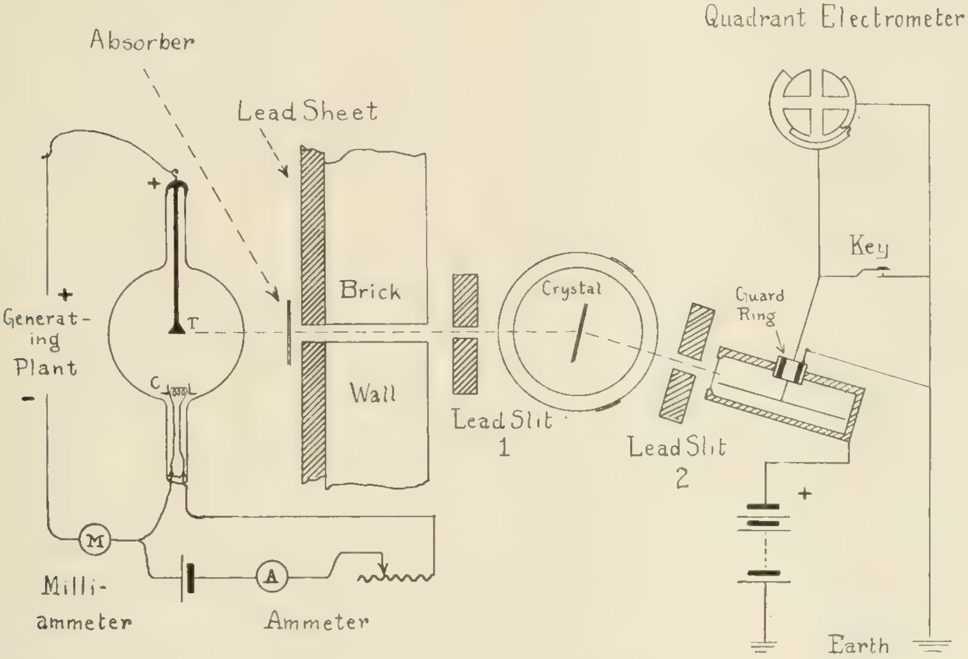


Fig. 4. Diagram of *x*-ray spectrometer.

THE WAVE-LENGTHS OF SCATTERED X-RAYS

Recent investigations of the distribution of intensity of *x*-radiation throughout water-phantoms, etc., have emphasized the importance of secondary and scattered *x*-rays. Perrin, in 1897, early in the history of *x*-rays, discovered the secondary radiation coming from substances on which *x*-rays fall. The question as to whether or not these secondary rays are as penetrating as the primary rays is one of great importance to the roentgenologist, not only on account of their influence on the distribution of radiation in a patient's body, but also from the point of view of the precautions that should be taken to protect the operator himself.

Recently, Dr. Clarke, Dr. Breit and the

writer have been investigating this problem by means of the x-ray spectrometer.[1] We have been studying the wave-lengths of the x-rays scattered from various substances. In general, short x-rays are more penetrating than longer ones. Further, the x-ray spectrometer furnishes us with the most accurate method of estimating the quality of radiation. Wave-lengths can be measured with far greater precision than can absorption coefficients. As the following experiments indicate, we have found that the scattered radiation from a great variety of chemical elements contains a large amount of radiation of exactly the same wave-length as the primary rays. This means that the scattered radiation contains a large number of x-rays of the same penetration as the primary rays. The scattered radiation consists of longer waves than the primary, also; that is to say, x-rays of very much less penetration than the primary. But the fact that the scattered radiation contains a large amount of radiation of the same wave-length and penetration as the primary radiation means that corresponding precautions must be taken for the protection of the operator, etc.[1]

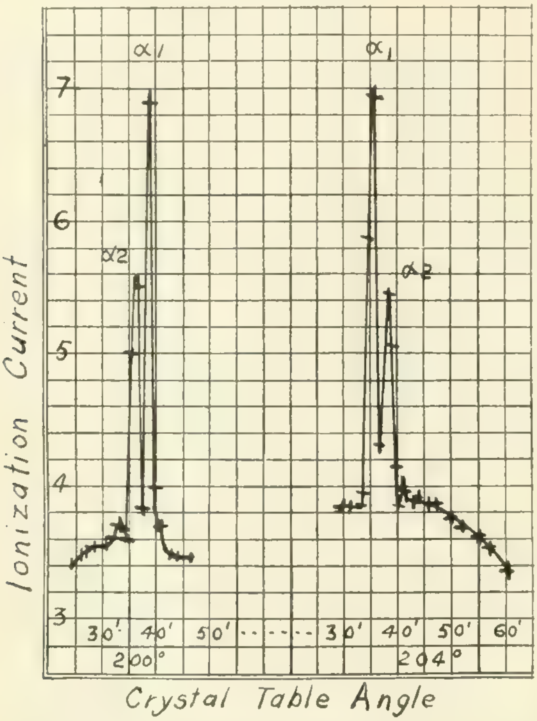


FIG. 5. The α lines in the spectrum of the x-rays coming directly from the target.

Our experiments on the secondary radiation consisted of two parts: In the first part we measured the wave-lengths of the x-rays coming from the tungsten target of the Coolidge x-ray tube.

Figure 4 represents the arrangement of the apparatus. The rays from the target T of the x-ray tube pass through a hole in a brick wall and then strike a crystal mounted on the table of the x-ray spectrometer. The planes in the crystal containing its atoms reflect x-rays having wave-lengths given by the formula

$$n\lambda = 2d \sin \theta,$$

according to Braggs' law. The reflected rays entering the ionization chamber represented in the figure produce a current which the quadrant electrometer measures. The curves in Figure 5 give the ionization currents at different angles of incidence, θ. The peaks on the curves represent the α lines in characteristic spectrum of the tungsten target. They have been measured on both sides of the zero of the instrument. The angles (half the angles measured from the peaks on one side to the corresponding peaks on the other) substituted in the above formula give for their wave-lengths the following values: for the peak α_1 $\lambda = 0.209$ and for the peak α_2 $\lambda = 0.213$ Ångströms.

In the second part of the experiment we measured the wave-lengths of the x-rays scattered from various materials. We employed exactly the same spectrometer set up in exactly the same way as in the first part of the experiment. We placed the x-ray tube in a vertical position, however, and shifted it to one side (as represented by Fig. 6) so that none of the rays coming from the tube could pass through the hole in the brick wall. As an additional precaution, a lead screen was placed between the tube and the first slit, as represented by A in Figure 6, so that none of the rays from the tube could strike the first lead slit. The substance producing the secondary rays was placed in line with the hole in the wall at B. With this arrangement of the apparatus the secondary rays from B alone could pass through the wall and enter the spectrometer. The readings of the spectrometer, therefore, measured the radiation given off from the substance B as secondary rays only.

---

[1] For details see *Proc. Nat. Acad. Sc.*, Dec., 1923.

[1] See the researches by A. H. COMPTON, *Bull. Nat. Research Council*, Oct., 1922, p. 16; *Phys. Rev.*, May, 1923, p. 483 and June, 1923, p. 715.

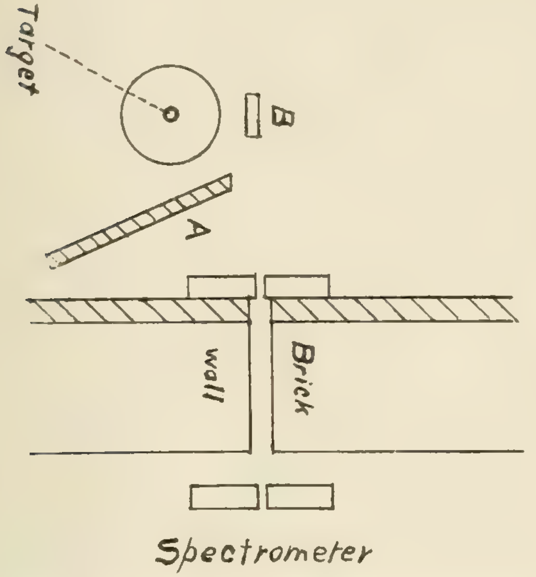


Fig. 6. Arrangement of tube and radiator for spectrum of scattered rays.

The curves in Figure 7 give the ionization currents for different positions of the crystal under these experimental conditions. We notice that the shapes of the curves are substantially the same as those in the first part of the experiment, although the peaks are not so completely separated from each other. In other words, the secondary radiation has substantially the same characteristics as the primary radiation. The peaks on the curves in Figure 7 occur at sensibly the same angles as those in Figure 5. Hence the wave-lengths, calculated from their positions by means of the above equation are, within the limits of error of measurements, the same as those of the primary rays. The secondary radiation, therefore, from the substance B (in this case carbon) contains a large amount of radiation of the same wave-length, i.e., of the same penetration, as the primary rays.

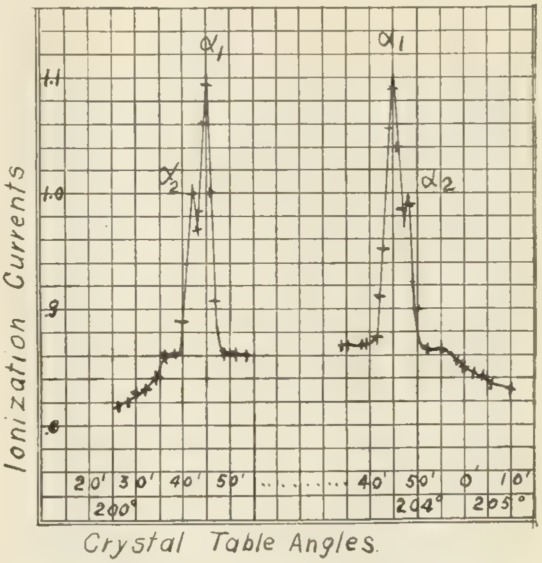


Fig. 7. The α lines in the spectrum of the x-rays scattered from carbon.

Similar results have been obtained for a variety of scattering substances containing chemical elements other than carbon—for instance, oxygen, aluminum, sulphur, potassium, copper, iodine, barium, lanthanium, praseodymium and neodymium.

THE ECONOMICS OF DOSIMETRY IN RADIOTHERAPY*

BY GIOACCHINO FAILLA, E.E., AND EDITH H. QUIMBY, M.A.

From the Laboratory of Biophysical Research of the Memorial Hospital

NEW YORK CITY

AT PRESENT the mode of action of radiation on the cancer patient is practically unknown. Some maintain that the primary object of irradiation is to destroy the cancer tissue directly, while others assert that the destruction of the neoplasm is brought about indirectly by the reaction of the normal tissue surrounding it. Whatever the mechanism may be which brings about the regression and eventual disappearance of the tumor, it is evident that a certain dose of radiation must be administered to the patient, whether the tumor or any other part of the body be irradiated. It is for the clinician to decide what this dose shall be, and how the radiation should be distributed within the tissues. In general there are several ways of fulfilling his requirements, one of which, however, is the most economical. In the present paper experimental data are presented which enable the radiologist to determine the relative amount of radiation at any tissue depth for different conditions of treatment, and to administer it in the most economical way.

The progress of radiation therapy depends in a large measure on the judgment of the radiologist as to the results he obtains from treatments given under definite conditions. First of all, he must have a good knowledge of neoplasms and their natural course. Then he must be familiar with the accepted methods of treatment and the results obtained thereby. It is only then that he can form an idea of the efficacy of the particular treatments which he gives. This is really self-evident, and need not be discussed further. We shall assume that the radiologist possesses these requisites, and that, therefore, he is properly equipped to form a just estimate of the results which come under his observation. No radiologist, however, can be expected to draw the correct conclusions from previous treatments and use the information thus obtained as a guide in his present work, unless he can rely on his machine to deliver the same dose of radiation under the same conditions. The modern American *x*-ray machines, judiciously handled, are quite reliable in this respect, so that the handicap of uncertain radiation is not serious. In fact, it can be overcome entirely by taking the proper precautions. We may conclude, then, that the radiologist on whom the further development of radiation therapy depends, possesses the proper knowledge of cancer and has at his disposal a reliable source of radiation.

These requisites alone, however, will not lead to rapid progress. In addition the radiologist must have quantitative data which give him a rational basis for his treatments and clinical observations. What are the data which he needs? Our present knowledge does not permit a categorical answer to this question. We cannot say with certainty that some factors have no influence in bringing about the effects of radiation which we observe. Accordingly the logical thing to do is to give all the factors involved.

Of the physical factors involved the most important one is the distribution of the radiation in the tissue (normal as well as pathological). It is only when this is known for every treatment that the radiologist can form the proper criterion for effective dosage. The Germans have done a great deal of work along these lines, but little has been done in this country. Some charts have been published from time to time, but they are of limited applicability since they refer only to a definite set of conditions of treatment. In our work we needed distribution charts for different conditions of treatment (that is, different target-skin distances, filters and diaphragms) for our machine. We decided to determine these charts experimentally by ionization measurements.

The work of Friedrich showed that a very small ionization chamber made of organic materials must be employed. Since no suitable instrument was available in this country, we proceeded to build one patterned after Friedrich's. We made some changes to increase the convenience of using such an instrument for a large number of measurements, but its essential features are the same as those of Friedrich's. It consists of a small ionization chamber made of clear bakelite, connected to a gold leaf electroscope by means of a rubber insulating cable. The electroscope is equipped with a projection device which enables the experimenter to observe the motion of the leaf on a ground glass screen instead of looking through a microscope. This arrangement reduces considerably the eyestrain when measurements have to be made for several hours continuously. The water-phantom is made of galvanized iron lined with wood 2 cm. thick, and is 30 cm. wide, 35 cm. long, and 30 cm. deep. It is equipped with a graduated screw so that the ionization chamber can be set at any height.

---

* The authors of this paper were awarded second prize. 300.00, in the Leonard Prize contest.

The information we wanted most urgently was for our deep therapy treatments, so the experiments were made with a machine operated at 200,000 volts crest value, and 4 ma. The voltage was determined in the following way: Keeping the milliamperes constant at 4 we measured the voltage *across the tube* by means of a sphere-gap constructed according to the Standardization Rules of the American Institute of Electrical Engineers, from the lowest point on the control to a maximum voltage of 210 kv. For each setting of the control handle we took many spark-gap readings quickly to eliminate as much as possible the effect of occasional surges. A voltmeter connected across the primary of the transformer was read at the same time. From the average of these readings the curve shown in Figure 1 was obtained. This relates the voltage applied to the tube to the primary voltage *when a current of 4 ma. flows through the tube.* The curve enables us to determine the impressed voltage for any setting by simply reading the primary voltmeter, *provided the current is 4 ma.* The advantage of this procedure lies not only in its simplicity but especially in its accuracy. The experimental points for the calibration curve are obtained by taking many readings for each setting. Then when an average curve is drawn we minimize errors still further.

With the machine set at 200,000 volts and 4 ma. we proceeded to determine depth dosage curves for 4 different diaphragms, 5 filters (3.67 mm. Al., 0.42, 0.84, 1.26, 1.68 mm. Cu.) and 2 target-skin distances (52.7 and 73.5 cm.). These would give us 40 different dosage curves (central beam only) for various combinations of diaphragm, filter and distance. In tabulating the experimental data definite relations were discovered which lead to some useful generalizations. Before proceeding to the discussion of the results, however, we must mention the precautions which were taken in making the measurements.

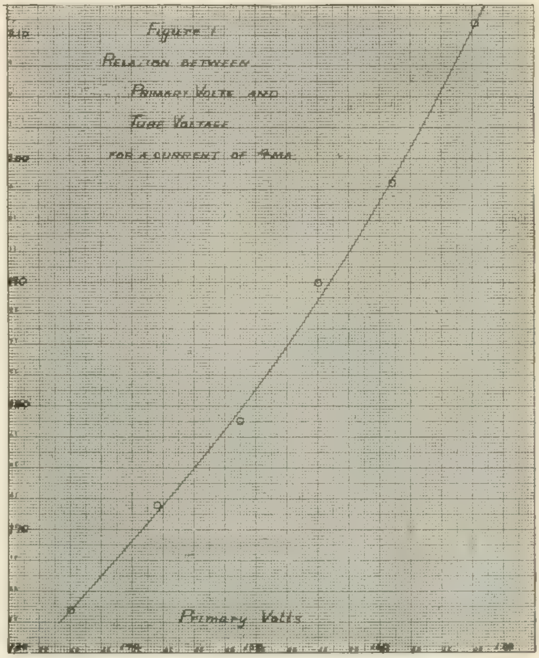


FIG. 1.

With an instrument of this type several sources of error must be considered. (1) *The natural leak of the electroscope.* This has been quite constant during the last eighteen months. Since errors due to variations in the leakage have the greatest effect on the longest readings taken, the natural leak was obtained always immediately after these readings. In the course of the day it was determined two or more times. The proper correction was then applied to all the readings. (2) *The effect of stray radiation on the electroscope and cable.* The electroscope is made of brass lined with 1 cm. of lead. The two windows are very small, one being 0.5 cm. and the other 1 cm. in diameter, and both are protected. The volume of the leaf house is small—4 × 4 × 1½ cm. Since the *x*-ray tube is practically enclosed in a lead-lined box, and the electroscope was always at a considerable distance from the tube, stray radiation had no appreciable effect on the electroscope. The possibility of ionization in the cable was considered and special tests were made to determine its magnitude. They showed that while the effect was present, it was negligible in our work. (3) *The "soaking" effect of the insulation.* This is always present in electroscope measurements, and it is very hard to correct for. We made a special test to determine what influence this had on electroscope readings varying in the ratio of 1:4 and found it to have no noticeable effect. We always charged the electroscope to the same point on the scale, and in the same manner. (4) *The effect of the cable on the amount of scattered radiation which reaches the ionization chamber.* An estimate of this was made by taking readings at different depths in the water-phantom with the ionization chamber as used ordinarily, and with a piece of cable held against its end. The addition of the cable-end decreased the ionization by about 4 per cent at a depth of 10 cm. in the phantom. At the surface the effect was not noticeable for filtered *x*-rays. (5) *The test for "saturation of the ionization chamber."* This was made by the use of radium. It was found that the electroscope readings were proportional to the amount of radium placed always in the same position relative to the ionization chamber, for a wider range of currents than that used in the experiments.

We shall now give the results of the experiments.

1. THE EFFECT OF THE SIZE OF THE FIELD ON THE AMOUNT OF RADIATION AT DIFFERENT DEPTHS

TABLE I

EFFECT OF SIZE OF FIELD ON SURFACE RADIATION

200 kv. (crest value) 4 ma., 73.5 cm. T-S distance
Ionization chamber half submerged

Field, sq. cm.	Filter, in millimeters None	3.27 Al.	0.42 Cu.	0.84 Cu.	1.26 Cu.	Average for Filtered Rad.
1000	100	100	100	100	100	100
237	95.2	92.3	92.6	92.0	90.6	91.9
118	90.9	86.5	86.8	87.0	86.2	86.6
41.5	84.0	79.4	79.0	78.8	78.7	79.0

The figures in Table I show that (*a*) the smaller the field the less the radiation effective at the surface; (*b*) the effect is substantially the same for the four filters shown; (*c*) a variation of the field from 1000 to 41.5 sq. cm. reduces the radiation by 21 per cent; (*d*) the effect is less marked for unfiltered rays. The same result was obtained with target-skin distances of 52.7 and 60.6 cm., and filters ranging from 3.27 mm. Al. to 1.68 mm. Cu.

TABLE II

EFFECT OF SIZE OF FIELD ON RADIATION AT 5 CM. DEPTH

200 kv. (crest value) 4 ma., 52.7 cm. T-S Distance

Field sq. cm.	Filter, in millimeters 3.27 Al.	0.42 Cu.	0.84 Cu.	1.26 Cu.	1.68 Cu.	Average for Cu. Filtered Rad.
1000	100	100	100	100	100	100
230	87.0	88.0	87.8	87.7	87.8	87.8
121	76.2	78.0	77.7	77.5	77.4	77.6
37.8	59.0	60.0	59.8	59.8	60.0	59.9

The figures of Table II show that (*a*) the smaller the field the less is the radiation effective at a depth of 5 cm.; (*b*) the effect is substantially the same for the 5 filters shown; (*c*) a variation of the field from 1000 to 37.8 sq. cm. reduces the radiation by 40 per cent. In this case also the same result was obtained with a distance of

73.5 cm. To avoid repetition we shall simply say that the same general conclusions apply to the radiation effective at a depth of 10 cm. Table III shows the results for one distance.

Table III

EFFECT OF SIZE OF FIELD ON RADIATION AT 10 CM. DEPTH

200 kv. (crest value) 4 ma., 52.7 cm. T-S Distance

Field sq. cm.	Filter, in millimeters					Average for Cu. Filtered Rad.
	3.27 Al.	0.42 Cu.	0.84 Cu.	1.26 Cu.	1.68 Cu.	
1000	100	100	100	100	100	100
230	82.3	82.0	81.0	81.5	81.8	81.8
121	70.0	68.6	68.7	68.5	68.5	68.6
37.8	48.1	49.4	49.6	48.9	49.3	49.3

We may make now the first generalization:

A. The effect of the size of the field on the radiation effective at any particular tissue depth is the same for all filters and all distances used in practice.

We are anxious not to convey a wrong impression by the wording of this generalization. We wish to call particular attention, therefore, to the limits of its applicability. The experimental data on which it is based covered the following ranges: Distance, 52.7 to 73.5 cm.; filter, 0.42 mm. Cu. to 1.68 mm. Cu., also 3.27 mm. Al.; skin area, 40 sq. cm. to 1000 sq. cm., the fields being rectangular with sides approximately in the ratio of 7:10; water depth, 0 to 10 cm. in the phantom already described. In addition, several special experiments were made to extend the range of the skin areas down to 20 sq. cm. and the range of the tissue depth to 15 cm. Within these limits for the different factors, therefore, the above generalization holds with a considerable degree of accuracy. That the limits can be extended somewhat on either side without introducing a large error can be readily granted. The final results are shown graphically in Figure 2. This supplies the necessary quantitative data to make the proper corrections in the dose according to the size of the skin area irradiated.

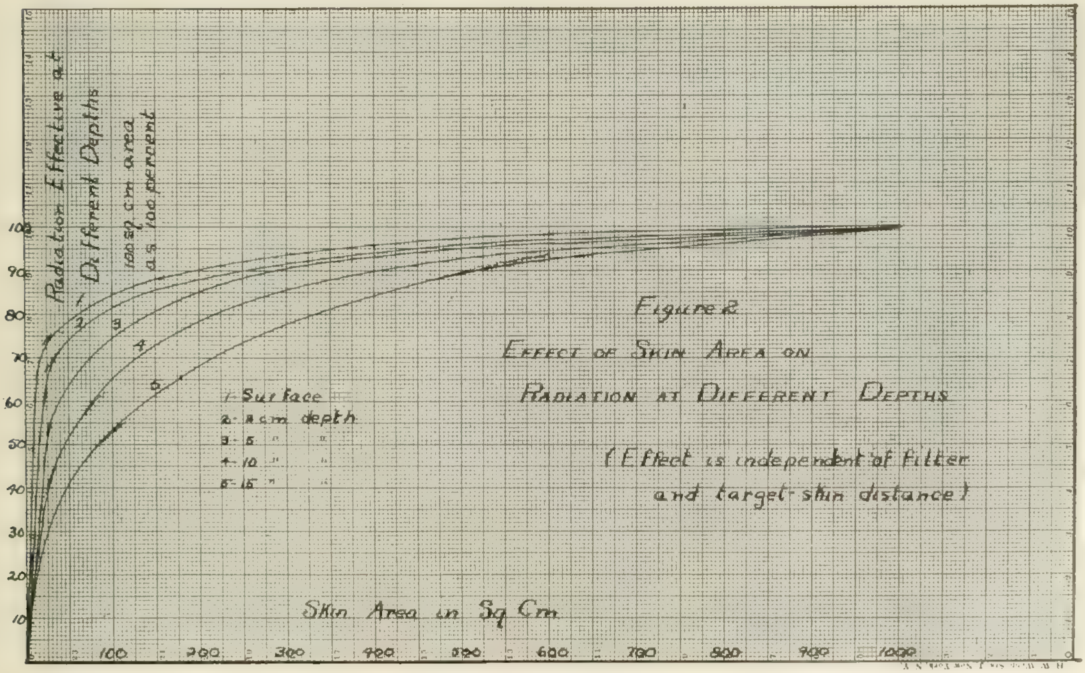


Fig. 2.

2. The Effect of the Filter on the Amount of Radiation Effective at Different Depths

Table IV

EFFECT OF FILTER ON SURFACE RADIATION

200 kv. (crest value) 4 ma., 73.5 cm. T-S Distance
Ionization Chamber Half Submerged

Copper Filter mm.	Area on Surface of Water, in sq. cm.				Average
	41.5	118	237	1000	
0	412	405	397	387	400
0.42	100	100	100	100	100
0.84	64.7	64.8	64.0	64.5	64.5
1.26	48.2	47.8	47.0	48.2	47.8

The figures given in Table IV show that the influence of the filter on the radiation effective at the surface is practically the same for fields ranging from 41.5 to 1000 sq. cm. when the surface of the water is 73.5 cm. from the target. The only considerable variation occurs for unfiltered radiation. This is probably due to the fact that the electroscope readings in this case were very short and therefore not very reliable. Since unfiltered radiation at this voltage is of no particular interest to us, no attempt was made to check the results. They are given here because they will serve as a guide in plotting the curve to represent the results graphically. The values for 3.27 mm. Al. were also obtained, but they are of little if any practical value and are omitted from the table. A similar agreement among the percentages for the four copper filters was obtained with a distance of 52.7 cm. and four different areas. Furthermore the percentages are essentially the same for the two distances. From this we may conclude that the effect of the filter on the surface radiation is independent of the irradiated area and the target-skin distance.

Tables V and VI show the influence of the filter on the radiation effective at a 5 cm. and 10 cm. depth respectively, for a distance of 52.7 cm. It will be seen that here also the relative effect of the filter is independent of the size of the irradiated area.

Table V

EFFECT OF FILTER ON RADIATION AT 5 CM. DEPTH

200 kv. (crest value) 4 ma., 52.7 cm. T-S Distance

Copper, mm.	Area on Surface of Water, in sq. cm.				Average
	37.8	121	230	1000	
0	232	227	221	214	224
0.42	100	100	100	100	100
0.84	66.7	66.7	66.7	66.7	66.7
1.26	49.7	49.7	49.8	51.2	49.7
1.68	38.3	39.2	38.5	39.3	38.8

Table VI

EFFECT OF FILTER ON RADIATION AT 10 CM. DEPTH

200 kv. (crest value) 4 ma., 52.7 cm. T-S Distance

Copper, mm.	Area on Surface of Water				Average
	37.8	121	230	1000	
0	176	189	176	186	181
0.42	100	100	100	100	100
0.84	68.4	70.2	69.5	70.2	70.0
1.26	51.8	53.2	53.2	53.3	53.2
1.68	42.3	43.2	41.8	42.8	42.3

It is hardly necessary to give the complete results for the determination at a 73.5 cm. distance. The average values obtained with three copper filters, however, are shown in Table VII.

Table VII

EFFECT OF FILTER ON RADIATION AT 5 AND 10 CM. DEPTH

200 kv. (crest value) 4 ma., 73.5 cm. T-S Distance

Copper, mm.	Average for all Fields Employed	
	5 cm. Depth	10 cm. Depth
0.42	100	100
0.84	67.4	71.4
1.26	49.5	54.9

The agreement between these values and the corresponding ones for the 52.7 cm. distance is not as good as in the previous cases. However it should be remembered that measurements at a 10 or even at a 5 cm. depth with a filter of 1.26 mm. of copper when the distance is 73.5 cm., are rather difficult, on account of the small amount of radiation reaching the ionization chamber. The maximum variation shown in Tables VI and VII occurs for the 1.26 mm. filter and is $\frac{54.9 - 53.2}{53.2} = 3$ per cent. It is not unreasonable, therefore, to attribute this to the inherent difficulty of the experiments at 73.5 cm. distance. Bearing in mind the practical applications of this work we are justified in making the second generalization.

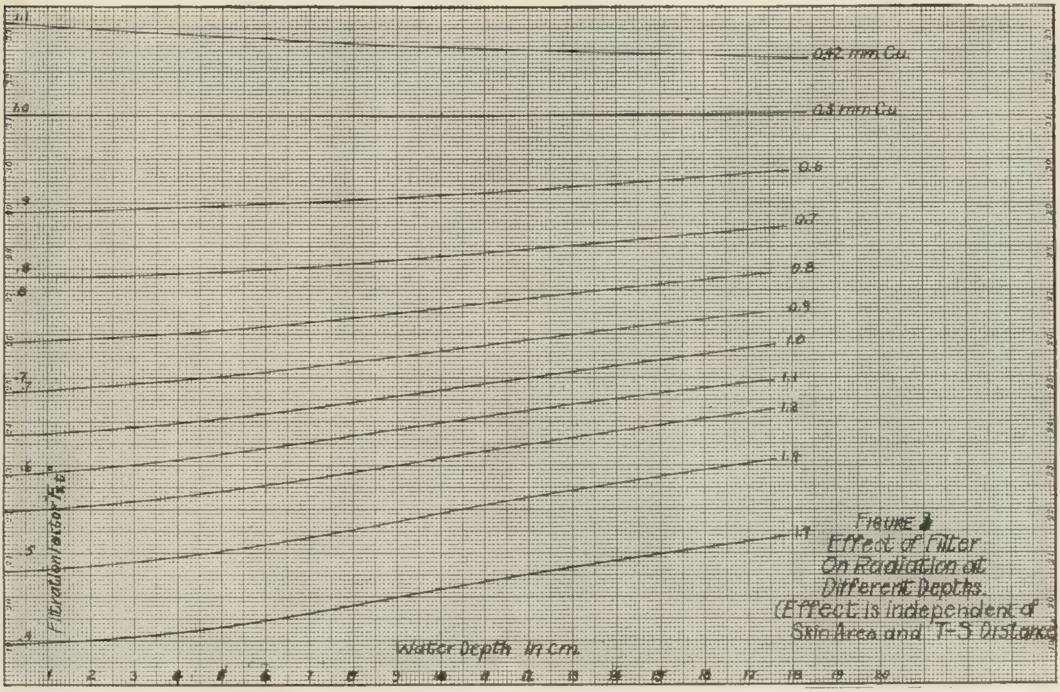


Fig. 3.

B. *The effect of the filter on radiation at any particular tissue depth is the same for all skin areas and all distances used in practice.*

The limitations of this generalization are similar to those for Generalization A and need not be discussed further. The range for tissue depths was extended to 15 cm. by subsidiary experiments. (The graphical representation of the results is shown in Figure 3, which will be explained later).

We may summarize the results presented so far by saying that the relative effects of the field of radiation and the filter are independent of each other and that both are independent of the target-skin distance.

3. THE EFFECT OF THE TARGET-SKIN DISTANCE ON THE AMOUNT OF RADIATION AT DIFFERENT DEPTHS

Figure 4 shows two dosage curves for the following conditions of treatment: A is for a target-skin distance of 52.7 cm., B for 73.5 cm. In both cases the filter is 0.42 mm. Cu., the skin area 120 sq. cm. (The voltage for all the data given in this paper is for 200,000 volts crest value). The curves show the effect on the relative depth doses of a change in distance from 52.7 to 73.5, the other conditions remaining the same. It will be seen that the difference in the depth dose at 10 cm. is from 34.2 per cent for the shorter distance to 37.9 for the longer one.

TABLE VIII

200 KV. (CREST VALUE) 0.42 MM. CU. FILTER 120 SQ. CM. FIELD

A	B	C	D	E	F	G
Depth, cm.	52.7 cm. Distance Per Cent Surface Radiation			73.5 cm. Distance Per Cent Surface Radiation		
	Meas.	Inv. Sq.	Ratio B/C	Meas.	Inv. Sq.	Ratio E/F
0	100	100	1.00	100	100	1.00
1	100	96.3	1.038	100	97.2	1.029
2	93.8	92.8	1.010	96.8	94.7	1.022
3	85.7	89.5	0.958	88.3	92.3	0.959
4	76.7	86.4	0.888	80.0	90.0	0.890
5	68.1	83.4	0.818	72.0	87.6	0.822
6	60.0	80.7	0.744	63.9	85.5	0.746
7	52.3	77.9	0.671	56.5	83.4	0.678
8	45.5	75.4	0.602	49.5	81.3	0.610
10	34.2	70.7	0.483	37.9	77.4	0.490
12	25.5	66.3	0.385	28.6	73.8	0.391
15	17.0	60.6	0.281	19.7	69.0	0.286

Since in the two curves the only factor which is different is the target-skin distance, we may reasonably expect the effect of the distance to depend on the inverse square law. In Table VIII we have listed the percentages read from the above curves and the percentages calculated by means of the inverse square law alone, for the two distances respectively. The equation is:

$$\text{Percentage of Surface Radiation} = 100\frac{X^2}{(X+Z)^2}$$

where x is the target-skin distance (52.7 or 73.5 cm. as the case may be) and z is the water depth (from 0 to 15 cm.). Taking the ratio between the experimental values and the values calculated from the above equation for each depth and the two distances we obtain the values shown in columns D and G. It will be seen that the agreement between the values for the two distances is quite close. The maximum variation occurs at the 15 cm. depth where the difference is less than 2 per cent. In order to make sure that the close agreement is not accidental we looked up Dessauer's[1] data and found even a better agreement. This is shown in Table IX. Here the ratios agree almost exactly for a range of target-skin distances from 30 cm. to 70 cm.[2] The better agreement is probably due to the fact that Dessauer's values for the different distances are referred to the same *volume* of water, whereas ours are for the same irradiated areas. Our data for the effect of the field (Fig. 2) enables us to make this correction and in that case the agreement is very close. Since, however, the error is small if the target-skin distances are not very different, we may neglect this factor. Dessauer's data shows also that the same general relation holds for different voltages and filters. (The ratios, of course, are different in each case.) This permits us to make the third generalization:

C. *If all the dosage factors except the target-skin distance are the same, the relative depth doses depend only on the inverse square law.*

TABLE IX

Depth, cm.	Target-skin Distance														
	30 cm.			40 cm.			50 cm.			60 cm.			70 cm.		
	Dess.	Inv. Sq.	Ratio	Dess.	Inv. Sq.	Ratio	Dess.	Inv. Sq.	Ratio	Dess.	Inv. Sq.	Ratio	Dess.	Inv. Sq.	Ratio
0	100	100	1.00	100	100	1.00	100	100	1.00	100	100	1.00	100	100	1.00
5	70.2	73.6	1.05	75.1	78.8	1.05	78.6	82.7	1.05	81.5	85.1	1.05	83.0	87.0	1.05
10	47.5	56.3	1.18	54.2	63.9	1.18	59.0	69.5	1.18	62.3	73.5	1.18	64.6	76.5	1.18
15	29.0	44.5	1.54	34.8	52.8	1.52	39.2	59.2	1.51	41.5	63.9	1.54	45.0	67.8	1.51

This is strictly true only when the same volume is irradiated at the distances considered. If the same skin area is maintained a small error is introduced for depths from 0 to 15 cm. We prefer to refer our data to the same skin areas, however, because this is simpler from the standpoint of the radiologist.

Having one curve of the type shown in Figure 4, for a definite set of dosage factors, Generalization C permits us to calculate similar curves for other distances, provided the remaining factors are the same. To make this clearer we shall take the data given in Table VIII for a 52.7 cm. distance and calculate the relative depth doses for a 73.5 cm. distance when the filter and skin area are the same as for the 52.7 cm. distance. The ratio in Column D will be assumed to apply to the 73.5 cm. distance, and all that is necessary is to multiply the inverse square law values for the different depths at the new distance by the corresponding ratios. This is shown in Table X. The experimental values for the 73.5 cm. distance are also given to show that the error introduced by our assumption is negligible.

---

[1] DESSAUER u. VIERHEELER. *Strahlentherapie*, xii, Heft 3, Seite 655.

[2] DESSAUER'S ratios cannot be expected to agree with those of Table VIII because the skin area and the filter in the two cases are very different.

TABLE X

Depth, cm.	73.5 cm. Distance			
	Ratio for 52.7 cm.	Inv. Sq. Law Value	Calculated Per Cent	Experimental Per Cent
0	1.00	100	100	100
2	1.01	94.8	95.6	96.8
4	0.868	89.8	78.0	80.0
7	0.671	83.3	56.0	56.6
10	0.484	77.5	37.5	37.9
15	0.281	68.9	19.4	19.7

In a similar way we can calculate curves for other distances. To minimize errors it is best to use the ratios for the 52.7 cm. distance for distances smaller than 50 cm. and the ratios for the 73.5 cm. distance for distances greater than 70 cm. For a distance of 60 cm. average values will be best. In general, however, we may take the average of the two ratios without introducing a serious error in the calculated depth doses for all target-skin distances used in practice.[1]

The combination of the three generalizations and the curves given so far enables us to calculate the depth doses *in percentage of the surface dose* for any target-skin distance, any skin area, and any filter used in practice (the voltage being 200 kv. crest value). The radiologist, however, must know also how to administer a skin dose under various conditions of treatment. For this purpose additional information is required.

4. THE APPLICABILITY OF THE INVERSE SQUARE LAW FOR SKIN DOSAGE

From time to time we have seen in the literature articles relating to the validity of the inverse square law. It should be remembered that this "law" is simply a geometrical relation which must necessarily hold for radiation emitted by a point source and traveling in straight lines. The only question to consider, therefore, is whether the conditions met with in radiotherapy justify the application of the inverse square law. It will be readily seen that the source of radiation is not strictly a point source and that the interposition of a filter changes the path of the rays to a certain extent, through scattering and the production of secondary radiation. Furthermore, the effect on the skin, which is principally what concerns us in this connection,

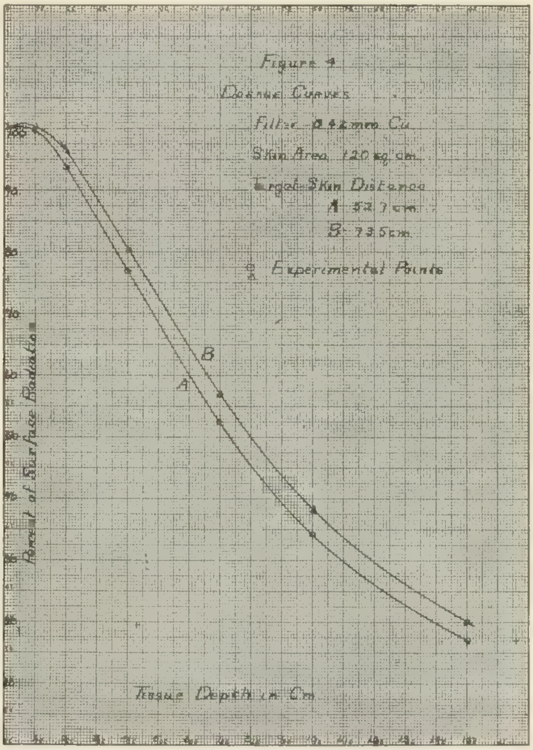


FIG. 4.

---

[1] A method of calculation similar to this is given by Dessauer. Ours is somewhat simpler because the same set of ratios applies to every distance. The same relation can be derived from Dessauer's data, although the ratios will be different.

depends not only on the amount of radiation falling thereupon, but also on the amount of radiation scattered backward by the underlying tissue. We may conclude a priori, therefore, that the inverse square law is not strictly applicable to our problem.

We made experiments to determine the variation of the surface radiation with the target-skin distance under various conditions of filter and irradiated area. In this work we employed also the small ionization chamber, since this would give us the most accurate information. The procedure was as follows: Readings were taken with the ionization chamber at different distances from the tube with several diaphragms and filters. In one set of experiments the chamber was supported in air and in another it was placed on the surface of the water in the phantom. We chose the half-submerged position of the chamber, since this is the position ordinarily taken for the zero depth in such measurements.[1] The data given in Table XI show that the inverse square law can be used to calculate skin doses for different distances *provided the same beam of radiation is maintained.* That is, provided the *same diaphragm* placed at the *same distance* from the tube is used for all distances. If the diaphragm is adjusted to give the same irradiated area at the different distances the inverse square law is not longer applicable.

Table XI

Ionization Chamber Half-submerged in Water Phantom. Diaphragm and Filter Placed at 40 cm. from Target

Distance Target cm.	Filter, in mm.			Average for all Filters	Calculated by Inverse Square Law
	3.27 Al.	0.42 Cu.	0.84 Cu.		
5 by 7 cm. Diaphragm					
50.9	100	100	100	100	100
60.6	71.3	71.9	70.2	71.3	70.6
73.5	46.7	48.8	48.2	47.9	47.8
7 by 10 cm. Diaphragm					
50.9	100	100	100	100	100
60.6	70.4	70.2	71.8	70.8	70.6
73.5	47.4	48.5	48.8	48.2	47.8

This is evident from the fact that the surface radiation is influenced by the size of the field and that the above condition of a fixed beam of radiation requires different areas at different distances (varying as the square of the distance).

The experiments with the ionization chamber in air (without water backing) gave the same results. That is, the inverse square law is applicable only when the same beam of radiation is measured at different distances, but not when the size of the *diaphragm* is changed from one distance to another. We found that, at the same distance, the larger diaphragm gave the larger ionization current, even though there was nothing below the ionization chamber which would scatter radiation back into it. (The wooden floor was more than one meter below the ionization chamber.) We had previously tested the cable for ionization and found it negligible, but in order to make sure that the effect was not due to radiation scattered by the cable into the chamber, we covered with lead the part exposed to the rays. This made no difference in the results. We concluded, therefore, that the increase in the ionization current with a larger diaphragm was due to the larger amount of radiation scattered by the filter when the cross-section of the beam was larger. This conclusion is substantiated by the observation that the ionization chamber registers a larger current when the filter is brought closer to it, even though other conditions remain the same. (This observation was made also by Friedrich.) Accordingly in this work it is important to specify the position of the filter. In all our experiments both the filter and the diaphragm were placed at a distance of 40 cm. from the target.

The results of these experiments enable us to make the fourth generalization:

D. *For purposes of Skin Dosage in Radiotherapy, the inverse square law is applicable, provided the same beam of radiation is effective at the different distances considered.*

This generalization permits us to calculate the proper dose to administer when we vary the target-skin distance, provided we know the dose for one distance and we use always the same diaphragm. In practice, however, it is necessary to adjust the size of the beam of radiation to the requirements of the case under treatment. For this purpose the inverse square law alone does not suffice. We can, however, work out correction factors which enable us to calculate the proper dose for any distance and any skin area. Going back to Generalization A we see that the effect of the size of the field on the surface radiation (zero depth) is the same for all practical distances. If a beam of radiation has a cross-section of 100 sq. cm. at a distance of 50 cm. from the target, the areas at other distances are as shown in Table XII.

---

[1] For the effect of the zero position for the ionization chamber see Weatherwax and Leddy, Am. J. Roentgenol., June, 1923, x, No. 6, p. 488.

TABLE XII

Distance, cm.	Area, sq. cm.
30	36
40	64
50	100
60	144
70	196
80	256
100	400

Hence if we know the skin dose for any one of these areas and the corresponding distance, the inverse square law determines it for all the other distances and the corresponding areas. Let us say, however, that we wish to know the amount of radiation effective at the center of a skin area of 100 sq. cm. at 70 cm. distance. Taking the radiation for a field of 100 sq. cm. at 50 cm. as unity, we determine by means of the inverse square law that the radiation from a field of 196 sq. cm. at 70 cm. is $1 \times \frac{50^2}{70^2}$ or 51 per cent. For an area of 100 sq. cm. it will be less than this, and Figure 2 enables us to obtain the proper value. Thus for an area of 196 sq. cm. the value from the proper curve in Figure 2 is 90, and for 100 sq. cm. it is 84.4. Hence the radiation effective at the center of an irradiated area of 100 sq. cm. at a distance of 70 cm. is $\frac{84.4}{90} \times 51 = 47.8$ per cent of that at 50 cm. with 100 sq. cm. area. The ratio $\frac{84.4}{90} = 0.938$ then, is the factor by which the inverse square law value of the radiation must be multiplied to obtain the correct amount for a field of 100 sq. cm. at 70 cm. In the same manner we can calculate the correction factors for the other distances. Such factors are given in Table XIII covering a wide range of distances and skin areas. They are all based on the value for each area at 50 cm. as unity.

5. THE DEVELOPMENT OF AN EQUATION FOR THE CALCULATION OF DOSES AT DIFFERENT DEPTHS, UNDER DIFFERENT CONDITIONS OF TREATMENT

The results of our experiments presented so far are accompanied by quantitative data which enable us to calculate the relative amount of radiation effective at any tissue depth for all practical conditions of treatment (the voltage being 200 kv. crest value). The process of calculation, however, is rather involved. To overcome this difficulty we have worked out an equation which reduces the process to one of simple substitution of the proper values for the factors involved. We shall explain this briefly. We have assumed as our unit the radiation required to produce a skin erythema at a distance of 50 cm. with a field of 100 sq. cm. and a filter of 0.5 mm. Cu. placed at a distance of 40 cm. from the target, the voltage being 200 kv. (crest value). It will be noticed that we do not state what constitutes an erythema, for this is immaterial as far as the values obtained from this equation are concerned. They will all be relative to whatever degree of erythema the radiologist wishes to adopt as his standard. This and the machine which he uses will determine the milliampere-minutes which will produce the standard erythema under the conditions specified above. The dosage curve for the standard conditions adopted is shown in Figure 5; the percentages read from this curve are listed in Column B of Table XIV. The percentages obtained by using the inverse square law are given in Column C. The ratios between the two appear in Column D. According to Generalization C these factors enable us to calculate the

TABLE XIII

BEAM AREA FACTORS bxa

T-S Distance, X = cm.	Area of Skin Irridiated, Square Centimeters											
	A = 25	A = 50	A = 75	A = 100	A = 150	A = 200	A = 300	A = 400	A = 500	A = 600	A = 800	A = 1000
35	1.075	1.075	1.072	1.086	1.068	1.067	1.067	1.059	1.057	1.052	1.040	1.031
40	1.053	1.049	1.048	1.045	1.045	1.042	1.038	1.037	1.033	1.030	1.020	1.016
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
60	0.958	0.963	0.963	0.967	0.967	0.971	0.972	0.978	0.982	0.987	0.995	
70	0.929	0.936	0.936	0.937	0.943	0.946	0.954	0.966	0.972	0.977	0.990	
80	0.883	0.915	0.916	0.918	0.923	0.929	0.942	0.958	0.962	0.968	0.981	
100	0.868	0.876	0.878	0.885	0.897	0.910	0.936	0.951	0.954	0.960	0.971	

TABLE XIV

200 kv. (Crest Value) 50 cm. T-S Distance
100 sq. cm. Field 0.5 mm. Cu. Filter (40 cm. from Target)

Tissue Depth, cm.	Experimental Values	Inverse Square Law Values	Ratio b/c = Rz
A	B	C	D
0	100	100	.100
1	100	96.1	1.04
2	93.5	92.4	1.011
3	85.4	89.0	0.960
4	75.1	85.7	0.876
5	67.4	82.7	0.815
6	59.1	79.7	0.742
7	51.2	76.8	0.667
8	44.5	74.3	0.599
10	33.2	69.4	0.478
12	24.7	65.0	0.380
15	16.6	59.2	0.281

TABLE XV

VALUES OF Rz

Tissue Depth, Z cm.	x = 50	x = 70	Average
0	1.00	1.00	1.00
1	1.04	1.03	1.035
2	1.011	1.006	1.008
3	0.96	0.945	0.952
4	0.876	0.870	0.873
5	0.815	0.803	0.809
6	0.742	0.730	0.736
7	0.667	0.657	0.663
8	0.599	0.582	0.590
9	0.537	0.520	0.529
10	0.478	0.467	0.472
12	0.380	0.368	0.374
15	0.281	0.267	0.274
18	0.193	0.180	0.186

percentages for any other distance provided the filter and the size of the field remain constant. Therefore for a field of 100 sq. cm. and a filter of 0.5 mm. of copper, the radiation effective at any depth Z is

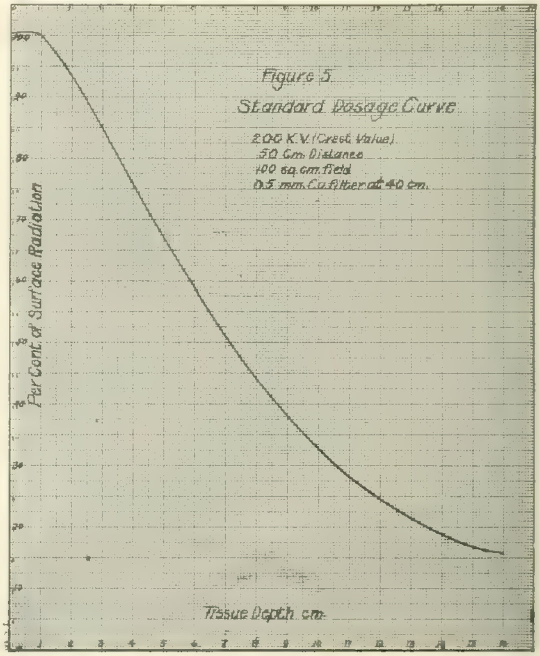


FIG. 5.

$$R = 100 \frac{X^2}{(X+Z)^2} r_Z$$

where x is the target-skin distance in cms.

Z is the tissue depth in cms.

r_Z is a factor whose values for different tissue depths Z are listed in Column D of Table XIV, and for more general conditions, in Table XV.

Thus, if we wish to calculate the relative radiation effective at a depth of 10 cm. when the target-skin distance is 70 cm., the field 100 sq. cm. and the filter 0.5 mm. Cu., we have $R = 100 \frac{(70)^2}{(70 + 10)^2} \times 0.478 = 36.6$ per cent of the surface radiation at 70 cm. (0.478 is the value of r_Z in Table XV corresponding to Z = 10 cm.).

TABLE XVI

EFFECT OF DIAPHRAGM AT DIFFERENT DEPTHS

Values of skin area factors a_{ZA}

Depth, cm. Z	Square Centimeter Area on Skin											
	A = 25	A = 50	A = 75	A = 100	A = 150	A = 200	A = 300	A = 400	A = 500	A = 600	A = 800	A = 1000
0	0.869	0.935	0.970	1.00	1.040	1.060	1.105	1.130	1.150	1.160	1.170	1.180
1	0.852	0.928	0.968	1.00	1.042	1.066	1.112	1.135	1.155	1.168	1.180	1.194
2	0.824	0.914	0.963	1.00	1.050	1.080	1.120	1.150	1.170	1.180	1.200	1.220
3	0.790	0.890	0.952	1.00	1.066	1.104	1.144	1.180	1.198	1.212	1.235	1.258
4	0.757	0.868	0.940	1.00	1.080	1.130	1.178	1.215	1.232	1.250	1.278	1.302
5	0.725	0.853	0.933	1.00	1.090	1.150	1.210	1.250	1.270	1.290	1.320	1.340
6	0.704	0.840	0.928	1.00	1.098	1.162	1.233	1.280	1.298	1.330	1.354	1.380
7	0.684	0.830	0.924	1.00	1.104	1.176	1.254	1.306	1.327	1.360	1.390	1.416
8	0.664	0.820	0.920	1.00	1.110	1.188	1.275	1.333	1.358	1.395	1.425	1.458
9	0.650	0.810	0.918	1.00	1.114	1.198	1.298	1.360	1.390	1.428	1.462	1.498
10	0.638	0.800	0.916	1.00	1.120	1.200	1.320	1.390	1.430	1.460	1.500	1.540
12	0.618	0.792	0.912	1.00	1.128	1.224	1.372	1.460	1.514	1.560	1.610	1.656
15	0.598	0.786	0.908	1.00	1.140	1.270	1.460	1.590	1.680	1.740	1.820	1.870
18	0.580	0.780	0.898	1.00	1.154	1.318	1.575	1.754	1.908			

For our purposes it is more convenient to express the results in terms of the unit defined above (50 cm. distance, 0.5 mm. Cu. filter, 100 sq. cm. field). The equation then becomes

$$R = \frac{50^2}{(X+Z)^2} r_Z \, b_{XA} \, a_{ZA}$$

where b_{XA} is a correction factor which takes account of the change in the beam of radiation when we maintain the same skin area at all distances. The subscripts $_X$ and $_A$ indicate that its value depends on the target-skin distance and the irradiated area.

a_{ZA} is the skin area factor which takes account of the effect of the size of the field at the 50 cm. distance. The subscripts $_Z$ and $_A$ indicate that its value depends on the tissue depth and the irradiated area.

Values of b_{XA} for different distances and different skin areas are given in Table XIII. Values of a_{ZA} for different skin areas and different tissue depths are listed in Table XVI.

This equation enables us to calculate the radiation effective at any tissue depth (0 to 18 cm.) for any target-skin distance and any size of field used in practice, but only for a filter of 0.5 mm. Cu. Our data for the effect of the filter on the radiation at different tissue depths enables us to enlarge the scope of the equation by the introduction of an additional factor f_{Zt} (the subscripts Z and t indicate that the values of this factor depend on the tissue depth and thickness of the copper filter). Values for different tissue depths and various copper filters are given in Table XVII. The final equation then becomes:

$$R = \frac{50^2}{(X+Z)^2} r_Z \, b_{XA} \, a_{ZA} \, f_{Zt}$$

Let us work out a few examples. What is the amount of radiation effective at a depth of 10 cm. if we use a target-skin distance of 50 cm., a filter of 1.0 mm. Cu. and a field of 400 sq. cm.?

$x = 50$, $Z = 10$, $r_{10} = 0.478$ (from Table XV)

$b_{50,400} = 1$ (from Table XIII) $a_{10,400} = 1.39$ (from Table XVI)

$f_{10,1} = 0.687$ (from Table XVII)

Hence

$$R = \frac{50^2}{(50 + 10)^2} \times 0.478 \times 1.39 \times 0.687 = 0.317$$

That is, the radiation at 10 cm. depth under the conditions of the problem is 31.7 per cent of the unit we have adopted. If we desire the percentage depth dose we have to divide the value obtained by the surface radiation effective under the same conditions. This is

$$R = \frac{50^2}{(50 + 0)^2} \times 1 \times 1 \times 1.13 \times 0.635 = 0.718$$

or 71.8 per cent of the unit we have adopted. Therefore, the percentage depth dose for the conditions of the problem is

$$\frac{0.317}{0.718} = 44.1 \text{ per cent.}$$

Table XVII

EFFECT OF FILTERS AT DIFFERENT DEPTHS

Values of filtration factors f_{Zt}

Depth, cm. Z	Mm. Copper										
	ft. = 0.42	ft. = 0.5	ft. = 0.6	ft. = 0.7	ft. = 0.8	ft. = 0.9	ft. = 1.0	ft. = 1.1	ft. = 1.2	ft. = 1.5	ft. = 1.7
0	1.111	1.00	0.890	0.808	0.740	0.684	0.635	0.590	0.548	0.480	0.397
1	1.107	1.00	0.891	0.810	0.742	0.686	0.637	0.593	0.550	0.482	0.399
2	1.100	1.00	0.892	0.812	0.744	0.688	0.639	0.596	0.553	0.484	0.400
3	1.096	1.00	0.893	0.814	0.746	0.692	0.643	0.600	0.558	0.489	0.404
4	1.093	1.00	0.895	0.817	0.749	0.697	0.648	0.606	0.564	0.494	0.408
5	1.090	1.00	0.897	0.820	0.755	0.702	0.653	0.612	0.571	0.502	0.416
6	1.088	1.00	0.899	0.824	0.760	0.708	0.658	0.619	0.578	0.510	0.424
7	1.086	1.00	0.902	0.828	0.765	0.714	0.664	0.626	0.586	0.519	0.432
8	1.084	1.00	0.904	0.832	0.770	0.720	0.671	0.634	0.594	0.527	0.441
9	1.082	1.00	0.906	0.836	0.775	0.726	0.679	0.642	0.602	0.536	0.450
10	1.080	1.00	0.908	0.840	0.781	0.733	0.687	0.650	0.610	0.545	0.460
12	1.076	1.00	0.915	0.844	0.791	0.745	0.700	0.664	0.626	0.563	0.478
14	1.072	1.00	0.922	0.848	0.801	0.756	0.713	0.678	0.642	0.582	0.496
15	1.070	1.00	0.925	0.860	0.808	0.763	0.720	0.685	0.650	0.590	0.505
18	1.064	1.00	0.935	0.876	0.825	0.781	0.740	0.706	0.690	0.617	0.532

In this problem we have selected the conditions which are usually given for comparison in American literature (distance 50 cm., field 20 × 20 cm. = 400 sq. cm., filter = 1.0 mm. Cu.). It will be seen that the value of 44.1 per cent for the dose at 10 cm. depth is in good agreement with the values reported by other investigators working with machines of different makes. From Bachem's report (Bachem. *J. Radiol.*, June, 1923, iv, No. 6) we may take 42 per cent as the average depth dose for American machines under the conditions specified above. If our results had not been corrected for the effect of the cable in shutting off some radiation from the ionization chamber, our percentage for these conditions would also be 42. This correction, to our knowledge, has not been made by other experimenters. It is very likely, therefore, that the difference is only apparent and not real.

Let us take another example. Determine the percentage radiation at a depth of 8 cm. under the following conditions: Target-skin distance 70 cm., filter 1.2 mm. Cu., field 300 sq. cm. Here $X = 70$, $Z = 8$, $r_8 = 0.582$ (from Table XV) $b_{70,300} = 1.047$ (from Table XIII) $a_{8,300} = 1.275$ (from Table XVI) $f_{8,\ 1.2} = 0.594$ (from Table XVII). Therefore

$$R = \frac{50^2}{(70 + 8)^2} \times 0.582 \times 1.047 \times 1.275 \times 0.594 = 0.181$$

or 18.1 per cent of our unit.

For the surface radiation $X = 70$, $Z = 0$,

$r_0 = 1$, $b_{70,300} = 1.047$, $a_{0,300} = 1.105$, $f_{0,\,1.2} = 0.548$

$$R = \frac{50^2}{(70+0)^2} \times 1 \times 1.047 \times 1.105 \times 0.548 = 0.324$$

whence percentage radiation at 8 cm. $= \frac{0.181}{0.324} = 56.3$ per cent.

We may discuss now the limit of applicability of the equation given above. In the first place its derivation is entirely empirical, there being no theory involved. It is a direct consequence of the four generalizations we developed from our experimental data, and therefore is subject to the same limitations. The tables we give for the values of the factors in the equation go only slightly beyond our experimental range, so that the extrapolation thus made cannot introduce large errors. Within the ranges for the different factors covered in our experiments the error is very small. This however, applies only to our machine under the conditions in which we use it. Since this is a typical American machine, and we have seen that the 10 cm. depth doses for several different machines of this type agree quite well, we may conclude that the equation with the factors we give may be used by others with a considerable degree of accuracy. Percentage values for other American machines[1] calculated by means of the equation and the factors given, probably would not vary from measured value by more than 5 per cent plus or minus. The measurements, of course, would have to be made with an instrument similar to ours.

The factor which varies a good deal with the machine, the tube and the radiologist (according to his idea of an erythema) is the milliampere-minutes required to produce a skin erythema under our standard conditions. It is very important to note that this *is not involved in the equation*. The values given by the equation are all in terms of a skin dose administered under the following conditions: Voltage 200 kv. (crest value), target-skin distance 50 cm., field 100 sq. cm., filter 0.5 mm. Cu. (A thin aluminum filter should also be used to remove the soft secondary radiation of the copper filter.) Each radiologist must determine for himself the milliampere-minutes required to produce an erythema under these conditions. Having done that, however, the equation will give him not only the depth doses, but also the milliampere-minutes for any other distance, filter and size of field. An example will make this clear. For our machine, 320 milliampere-minutes are required to produce a mild erythema on the average patient, under the conditions adopted as standard for the equation. Accordingly in our case our unit skin dose requires 320 milliampere-minutes. The equation enables us to calculate the surface radiation under different conditions in terms of this unit. The milliampere-minutes will be inversely proportional to the amount of radiation effective at the surface as calculated. Thus for a 70 cm. distance, a field of 150 sq. cm. and a filter of 1 mm. Cu., the surface radiation is

$$R = \frac{50^2}{(70+0)^2} \times 1 \times 1.061 \times 1.04 \times 0.635 = 0.356$$

Therefore milliampere-minutes $= \frac{1}{0.356} \times 320 = 900.$

This value for the milliampere-minutes applies only to our machine, since it is based on 320 ma.-min. for the standard dose. The ratio $\frac{1}{0.356}$ however, is probably applicable to other machines of the same type for the change in distance, filter and area here considered. For any other set of conditions it can be calculated in a similar manner. We are unable to compare directly our ratios for the different filters with those obtained for other machines, because there is practically nothing in the literature on this subject. We cannot say, therefore, just what error might be introduced in transferring our data for the filtration factors to other machines for purposes of skin dosage. The skin area factors (a_{ZA}) and the beam area factors (b_{XA}), however, can be used for all machines without appreciable error.

A radiologist may make an indirect comparison of the radiation produced by his machine with the radiation which we used in our experiments by determining the "effective" wave-length according to

---

[1] It is safest not to assume that the equation applies to machines of the Rieber design or continuous current machines.

Duane's methods.[1] We have determined the effective wave-length using three different ionization chambers, and the results are shown in Table XVIII.

TABLE XVIII

A	B	C	D	E	F	G	H	K
	Small Bakelite Chamber				Large Chamber Silk Plates		Large Chamber All Alumimum Plates	
	In Air		On Water					
Cu. Thick. in mm.	Per Cent Trans-mitted	Eff. Wave Length A. U.	Per Cent Trans-mitted	Eff. Wave Length A. U.	Per Cent Trans-mitted	Eff. Wave Length A. U.	Per Cent Trans-mitted	Eff. Wave Length A. U.
0	545	.....	458	.....	329	.....	390	
0.2	201	.....	183	.....	176	.....	190	
0.4	117	.....	116.8	.....	114	.....	118	
0.5	100	0.152	100	0.156	100	0.155	100	0.168
0.7	81.4	.....	81.1	.....	82.2	.....	77.3	
0.75	78.7	0.150	77.8	0.150	79.2	0.149	73.3	0.158
1.0	65.2	.....	64.5	.....	66.7	.....	59.7	
1.2	58.1	.....	56.7	.....	58.3	.....	49.6	
1.5	47.8	.....	45.6	.....	46.7	.....	39.5	
1.7	41.6	.....	40.0	.....	41.1	.....	35.0	
1.75	39.3	.....	38.4	.....	40.3	.....	32.7	

The figures in Columns B and D were obtained with the small bakelite chamber; those in Columns H and F with large ionization chambers having plates of aluminum and silk ribbon, respectively. It will be seen that all the values of the effective wave-length (for radiation transmitted through 0.5 and 0.75 mm. Cu.) agree except those obtained with the "aluminum" ionization chamber (the aluminum plates of this chamber make up a total thickness of one millimeter). It is to be noted that the values given in the Column B were obtained with the chamber in air while the values of Column D were obtained with the chamber half submerged in the water phantom. They are averages of a large number of determinations made at different distances from the Coolidge tube and with different diaphragms. These represent most closely the radiation which is effective on the surface. Duane[1] states that for a voltage of 200 kv. (crest value) the effective wave-length for radiation filtered by 0.5 mm. Cu. is in the neighborhood of 0.16 A. U. Glasser[1] gives 0.15 A. U. as the effective wave-length for the above voltage, and 0.75 mm. Cu. This is in good agreement with our values. Both Duane and Glasser used different machines from ours. We can be fairly sure, therefore, that our values for the filtration factors can be applied to other machines without introducing a large error.

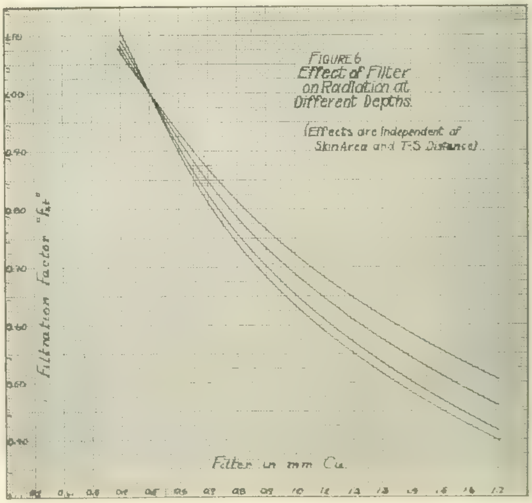


FIG. 6.

---

[1] DUANE, W. AM. J. ROENTGENOL., Dec., 1922, ix, 781.

[1] GLASSER, O. AM. J. ROENTGENOL., May, 1923, x, 405.

Before leaving this subject we wish to point out the simplicity of using the equation. In the first place very little thinking is required. The radiologist simply writes down the data of the problem as shown below:

$$R = \frac{50^2}{(X+Z)^2} r_Z b_{XA} a_{ZA} f_{Zt}$$

Target-skin distance $X = 60$ cm. (for instance)
Tissue depth $Z = 10$ cm.
Thickness of Cu. filter $t = 0.8$ mm.
Area of field $A = 200$ sq. cm.

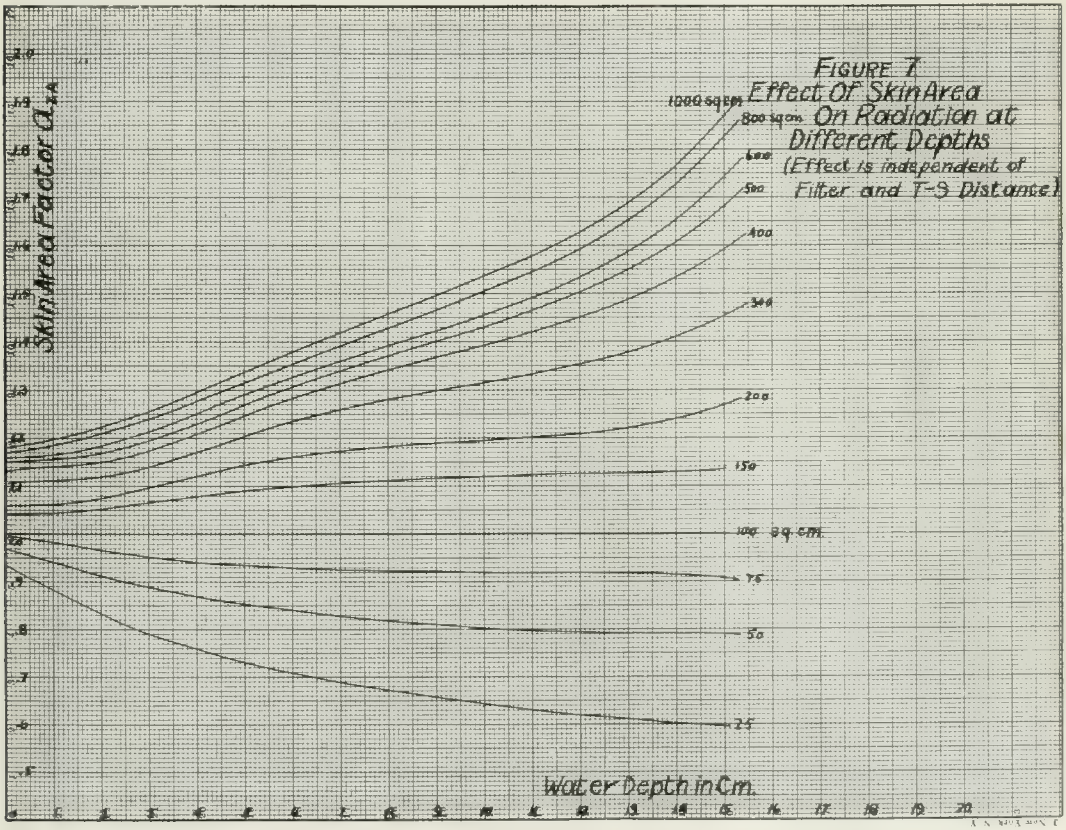


FIG. 7.

Then he writes down the symbols for the factors with the proper subscripts, thus:

$r_Z = r_{10}$ $(Z = 10)$
$b_{XA} = b_{60,200}$ $(X = 60, A = 200)$
$a_{ZA} = a_{10,200}$ $(Z = 10, A = 200)$
$f_{Zt} = f_{10,0.8}$ $(Z = 10, t = 0.8)$

He is now ready to look up the proper values for these constants from the tables given. Thus in Table XV, for $z = 10$ he finds 0.467 for the value of r_{10}. Therefore he sets down[1] $r_z = r_{10} = 0.467$. Similarly he looks up the value of $b_{60,200}$ in Table XIII. The desired value is found in the line for $X = 60$ and the column for $A = 200$. It is 1.030. Therefore $b_{XA} = b_{60,200} = 1.030$. In Table XVI he finds the value for $a_{10,200}$ at the intersection of the line for $z = 10$ and the column for $A = 200$. Hence $a_{ZA} = a_{10,200} = 1.20$.

In a similar manner he finds the value of $f_{10,\ 0.8}$ in Table XVII at the intersection of the line for $Z = 10$ and $t = 0.8$.

That is $f_{Zt} = f_{10,\ 0.8} = 0.781$.

Substituting these values into the equation he finds the amount of radiation for these conditions in terms of the unit adopted here.

$$R = \frac{50^2}{(60 + 10)^2} \times 0.478 \times 1.030 \times 1.20 \times 0.781 = 0.236$$

---

[1] In practice he would write the value next to the symbol in the above list. This, however, would cause confusion in this explanation.

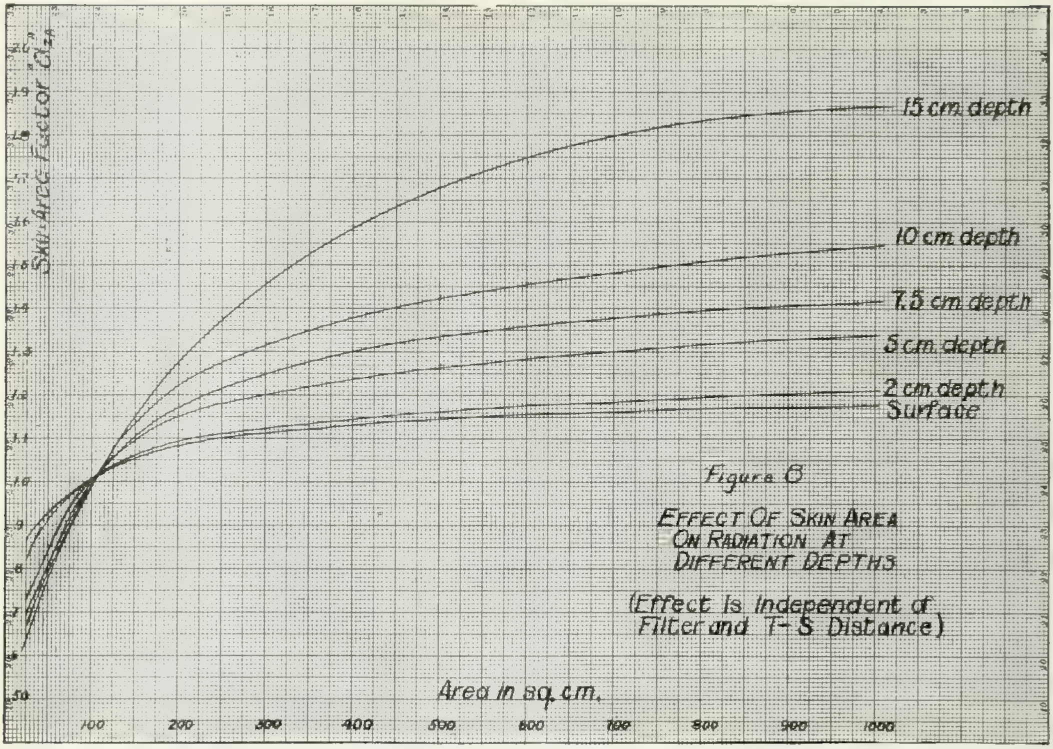

Skin Area Factor C_{SA}
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.50
15 cm. depth
10 cm. depth
7.5 cm. depth
5 cm. depth
2 cm. depth
Surface
Figure 8
EFFECT OF SKIN AREA ON RADIATION AT DIFFERENT DEPTHS
(Effect Is Independent of Filter and T-S Distance)
Area in sq. cm.
100
200
300
400
500
600
700
800
900
1000

Fig. 8.

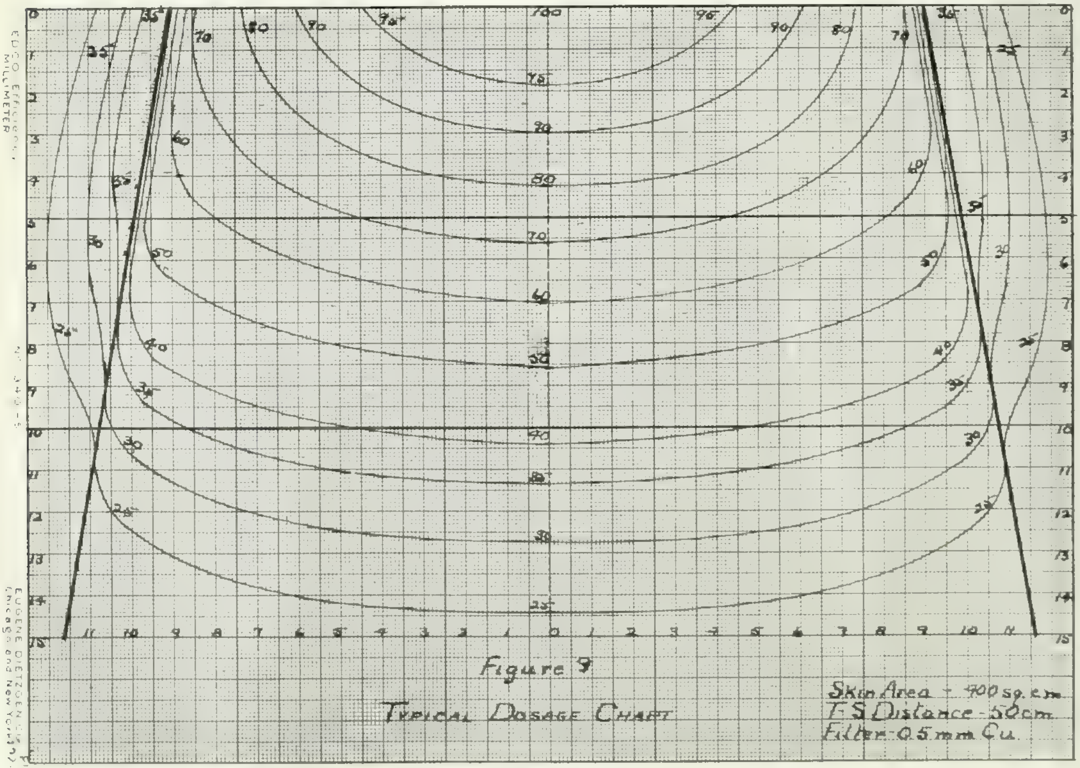

0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
100
95
90
80
70
60
50
40
35
30
25
11
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
Figure 9
TYPICAL DOSAGE CHART
Skin Area - 400 sq. cm.
T-S Distance - 50 cm.
Filter - 0.5 mm Cu.

Fig. 9.

(Using the slide rule the above calculation can be made in less than one minute.)

To determine the depth dose in *percentage of the skin dose for the same conditions* it is necessary to calculate the surface radiation. Some of the factors will be the same as in the previous determination, but it is best for the radiologist to look up all of them and list them in the manner shown above as if this was an entirely new problem. For the sake of brevity we do not do this here.

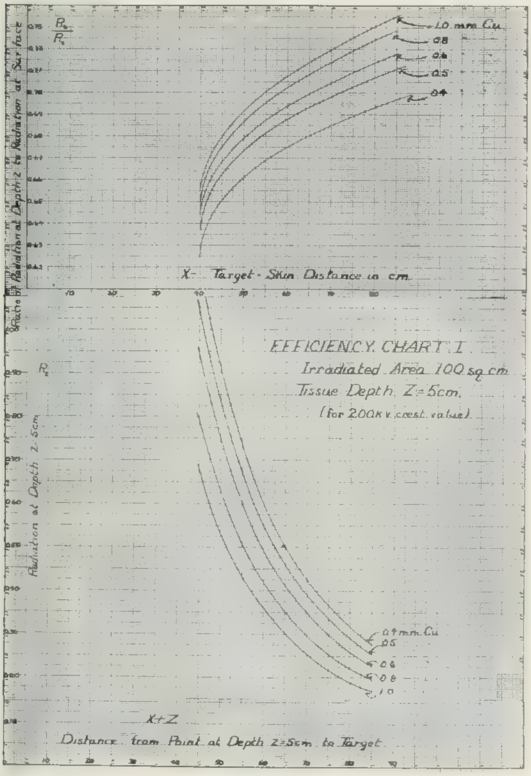


Chart I.

$$R_{\text{surface}} = \frac{50^2}{(60+0)^2} \times 1 \times 1.030 \times 1.06 \times 0.74 = 0.561$$

Therefore the percentage dose $= \frac{0.236}{0.561} =$ 42.1 per cent for the conditions of this problem.

The use of this equation is practically a mechanical process. The only thing that the radiologist must remember is that the results are always given in terms of the surface radiation delivered under the standard conditions of the 50 cm. target-skin distance, 100 sq. cm. field, 0.5 mm. Cu. filter, the voltage being 200 kv. (crest value). (By substituting in the equation the value of the different factors for these conditions it will be seen that $R = \frac{50^2}{(50+0)^2} \times 1 \times 1 \times 1 \times 1 = 1$.)

The four tables given in this paper for the factors involved in the equation enable us to calculate values of R for over 30,000,000 combinations of distance, area of field, filter and tissue depth. Values for the factors intermediate to those given, however, might be desired in practice. For this purpose we have worked out the curves shown in Figures 3, 6, 7 and 8. It is perhaps superfluous to explain the use of these charts.

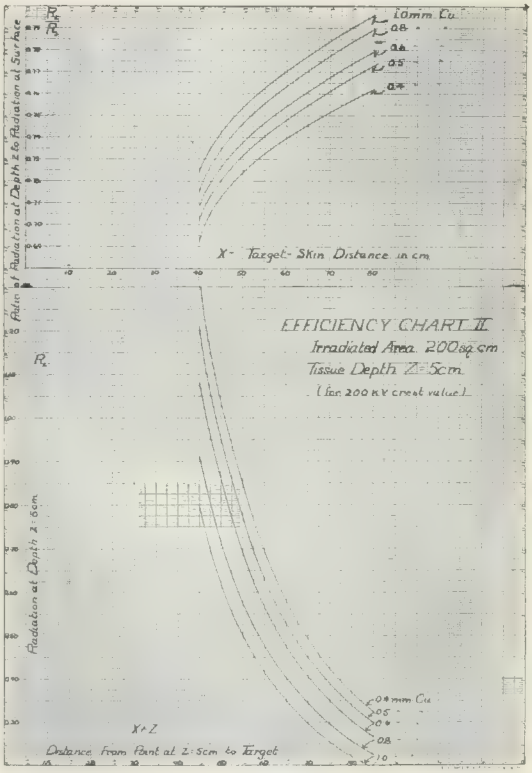


Chart II.

EFFICIENCY CHARTS

The data we have presented so far offer a method of comparing the amount of radiation available at any tissue depth under different conditions of treatment. The information we may derive from such comparisons is quantitative. For instance, if we compare two treatments given under the same conditions except for the size of the field, we can tell not only which one supplied the larger amount of radiation at a certain depth, but also *how much more* the radiation was. We shall make use of this fact now to determine the most efficient or economical way of delivering the desired amount of radiation at a given tissue depth.

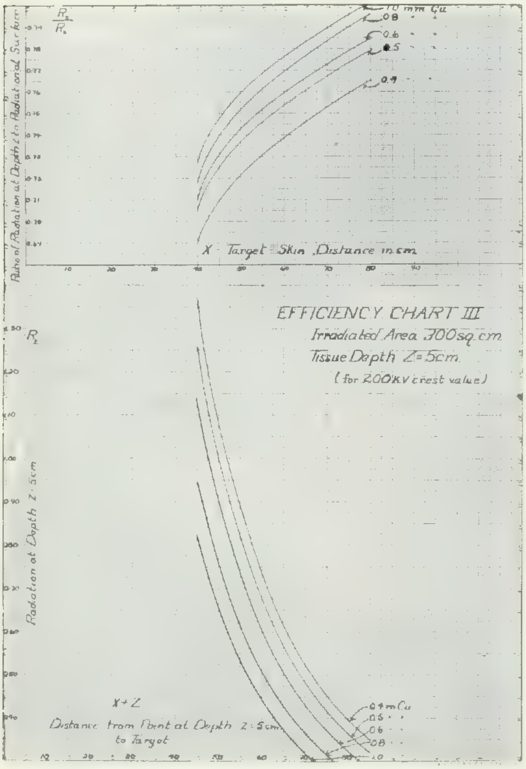


Chart III.

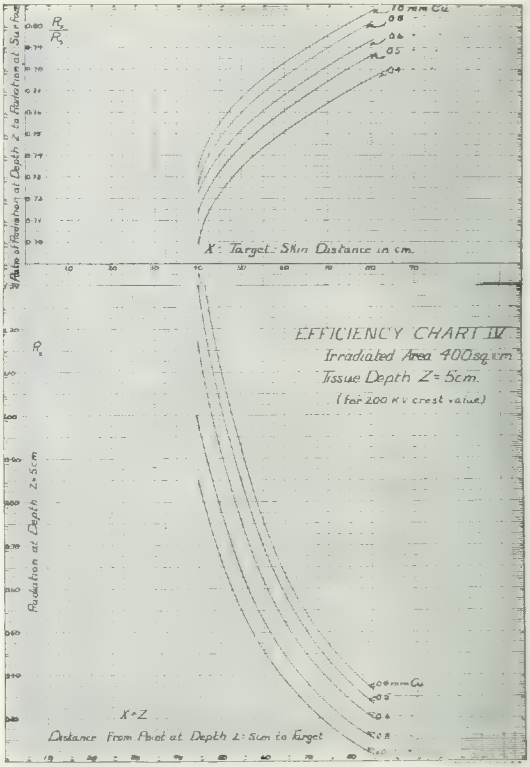


Chart IV.

We know that an increase in the area of the field, the thickness of the filter, or the target-skin distance separately, results in an increased depth dose, other conditions being the same. Therefore if we wish to vary the depth dose when the same skin dose is administered, we have three separate ways of doing so, or we may combine all three. In practice really, the size of the field in general is set by the requirements of the case we are treating. For any particular case, therefore, the methods of choice reduce to two or a combination of these. Taking as a criterion the length of the treatment required to deliver the desired amount of radiation at a certain depth, it will readily be seen that there must be a happy combination of the different factors which will result in the shortest treatment for the given depth dose. To work out this problem we must know the depth dose, not only in percentage of the skin dose, but relative to a fixed standard. It was with this idea in mind that, for the equation given above, we adopted as a unit the surface radiation required to produce an erythema at 50 cm., with a field of 100 sq. cm. and a filter of 0.5 mm. Cu. (placed on the diaphragm at a distance of 40 cm. from the target). All other figures obtained thereby are in terms of this unit. It is hardly necessary to add that the results are independent of the unit.[1]

---

[1] If the distance between two points is expressed in feet, yards or miles it is immaterial to the man who is walking from one to the other. He will have to expend the same amount of energy in any case.

We have worked out a graphical method which enables us to determine the most efficient or economical conditions of treatment to deliver a certain dose of radiation at a given tissue depth. A number of such "efficiency" charts are included in this paper. For the sake of brevity we shall not describe the construction of these charts, but simply explain their use. Taking Chart VIII as a typical one we have: An irradiated skin area of 400 sq. cm. (field 20 × 20 cm.) and a tissue depth of 10 cm. These conditions are set by the requirements of the case we wish to treat. We decide that the dose at a depth of 10 cm. shall be 80 per cent of a skin dose, and that it is to be administered through two opposite skin areas (400 sq. cm.). Accordingly for either area the dose at 10 cm. is 40 per cent or the ratio between depth radiation and skin radiation is $\frac{R_z}{R_s} = 0.40$. Going to the efficiency chart (VIII) now, we find on the scale for $\frac{R_z}{R_s}$ the point corresponding to a ratio of 0.40 and we draw a horizontal line A intersecting the curves M for the different filters. From the points of intersection we draw straight lines B to meet the corresponding curves N below; and from these we draw horizontal lines C to the scale for radiation at depth z = 10 cm. We are ready now to read the results. The lines B intersect the scale of target-skin distance at different points. These determine the distances which, coupled with the corresponding filters, will give a ratio of 0.40 between the surface radiation and the radiation at a depth z = 10 cm. Thus if a filter of 0.5 mm. Cu. is used, the target-skin distance must be 47.0 cm. to give the required percentage depth dose. Similarly for a filter of 0.6 mm. the required distance is 44.0 cm.; for 0.8 mm. it is 40.5 cm.; for 1 mm. it is 39.5 cm., etc. It will be noticed that the distance is shorter the thicker the filter, which is as it should be.

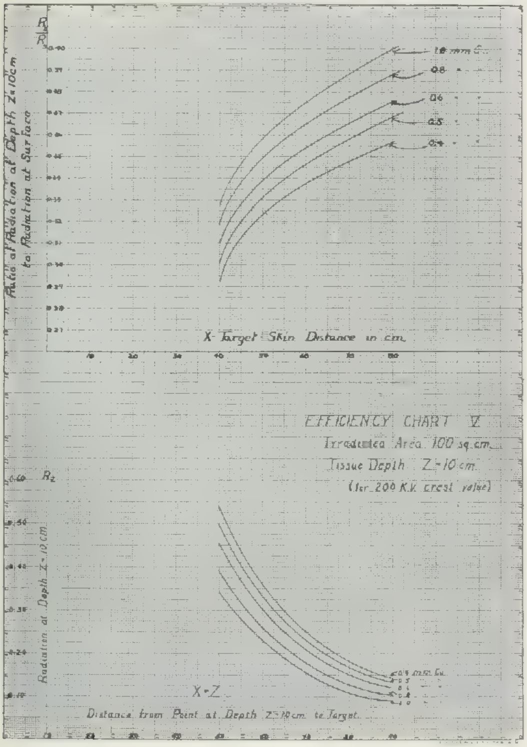


Chart V.

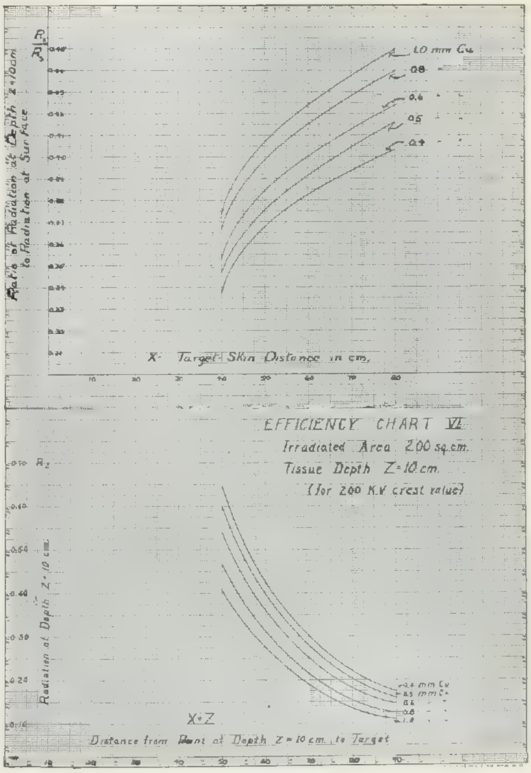


Chart VI.

All these pairs of filter and distance fulfil the condition that the ratio $\frac{R_{z=10}}{R_s}$

= 0.40. Of these, however, only one is the most economical from the standpoint of the duration of treatment. We determine this in the following way: The intersections of the lines C and the scale of radiation at depth z = 10 cm. give us the values of the depth radiation corresponding to each set of filter and distance. The combination which gives the largest value for R_Z is the most economical to use.

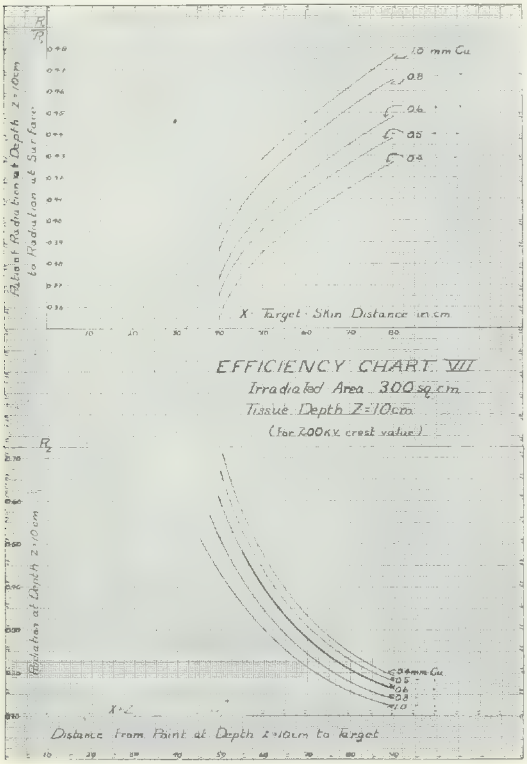


Chart VII.

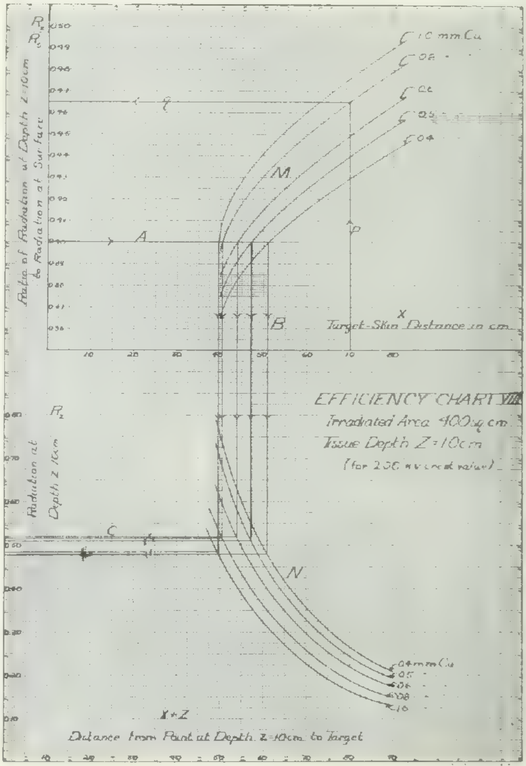


Chart VIII.

It will be seen at a glance from the chart that for this example the most economical combination is a filter of 0.6 mm. Cu. and a target-skin distance of 44.0 cm. Note that either a smaller filter or a larger one would be less economical in this case.

The next thing we wish to know is what milliampere-minutes to use to administer a skin dose under the conditions worked out for the chart; that is, 44.0 cm. distance, and 0.6 mm. Cu. We can do this by using the equation as already explained or more simply by means of the same chart. Thus the line C for 0.6 mm. Cu. intersects the scale for the radiation at depth z = 10 cm. at the point $R_z = 0.52$. This is the radiation at the 10 cm. depth in terms of our unit. Since the ratio between surface and depth radiation for this problem is 0.40, the surface radiation will be $\frac{0.52}{0.40} = 1.30$ units. As already stated, with our machine it takes 320 ma.-min. to deliver the unit of radiation adopted. Hence in our case we would have to use $\frac{320}{1.30} = 246$ ma.-min. to give a unit erythema dose under the new conditions. The value 320 ma.-min. varies from one clinic to another, but the factor 1.30 (or any other obtained from the chart) is applicable to practically all American machines without perceptible errors.

If we calculate the milliampere-minutes for each filter and distance which will give a ratio $\frac{R_z}{R_s} = 2.40$, we can get an idea of the saving in time involved. This is shown in Table XIX.

Table XIX

Filter mm. Cu.	Distance cm.	R_z	R_s	Ma.-min. for our machine	Minutes	Per cent
0.4	51.0	0.486	1.22	262	68	111
0.5	47.0	0.512	1.28	250	62.5	102
0.6	44.0	0.520	1.30	246	61.5	100
0.8	40.6	0.516	1.29	248	62.0	101
1.0	39.5	0.480	1.20	267	67.2	100

It will be seen that for filters of 0.5, 0.6 and 0.8 mm. Cu., the time of treatment is practically the same. For a filter of 1.0 mm. Cu. the time is 9 per cent longer than for the most economical conditions; in practice the radiologist would probably use a 50 cm. target-skin distance. In that case the 1 mm. Cu. filter would necessitate a treatment of 436 ma.-min., or 44 per cent longer than the most economical one. The ratio $\frac{R_z}{R_s}$ in this case would be larger than before, but even if he adjusted the skin dose (giving less than an erythema dose) to get the same radiation at the 10 cm. depth, he would have to give a treatment of 396 ma.-min., or 16 per cent longer than the most economical one.

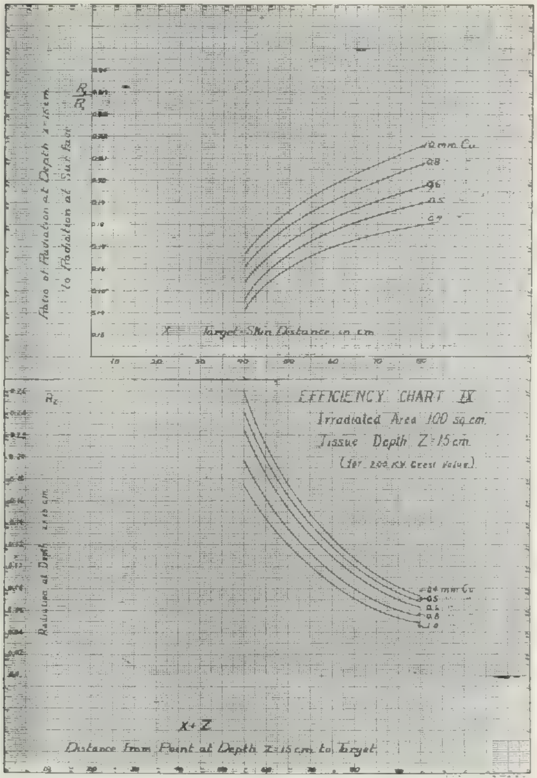


Chart IX.

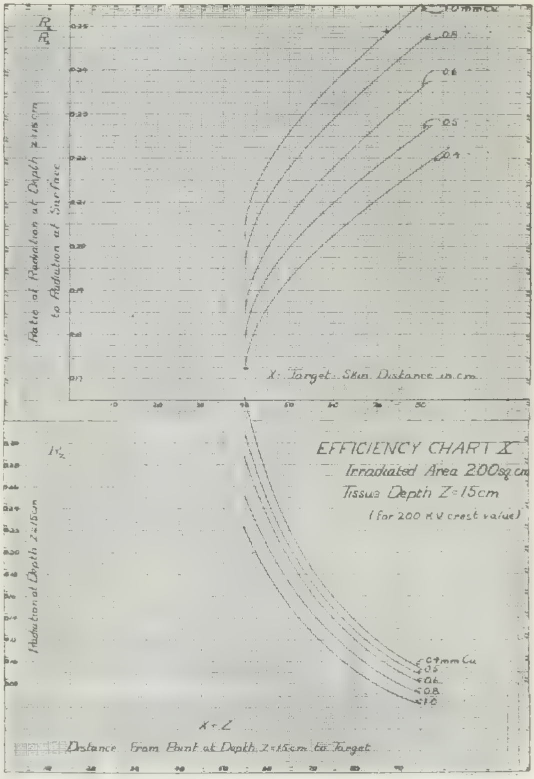


Chart X.

The above example illustrates the use of the charts for determining the most economical filter and distance in a simple case. In practice usually the requirements of the case are more complicated than we have assumed in the example. It is not necessary, however, to give more details since the method is the same. The use of dosage charts similar to Dessauer's to map out the treatment is to be recommended. Then for each port of entry our efficiency charts will determine the most economical filter and distance to be used. A typical dosage chart is appended to this paper.

The efficiency charts can be used for purposes other than the one outlined above. Thus the radiologist can determine at a glance what dose is possible to deliver at a certain depth with a given number of fields, or vice versa. For instance, taking

Chart IX he can tell immediately that with a field of 100 sq. cm., he cannot deliver one skin dose at 15 cm. by using four ports of entry (unless he uses a distance of perhaps 150 cm. and a thick filter, which is not practical). Chart X shows that if he uses fields of 200 sq. cm. he can do so. The larger fields are always more economical. Which one to use, however, must be decided on clinical ground alone.

Another use of the charts might be mentioned here. The percentage depth radiation can be determined from the charts for the conditions of treatment which they cover. Thus, using Chart VIII we can find the percentage radiation at 10 cm. depth for a field of 400 sq. cm., a distance of 70 cm. and a filter of 0.8 mm. Cu., by drawing a line p from 70 on the target-skin distance scale to the curve for 0.8 mm. Cu. and thence a line q to the ratio scale. At the point of intersection we find $\frac{R_s}{R_z} = 0.468$. Hence the percentage radiation at 10 cm. depth for those conditions is 46.8 per cent.

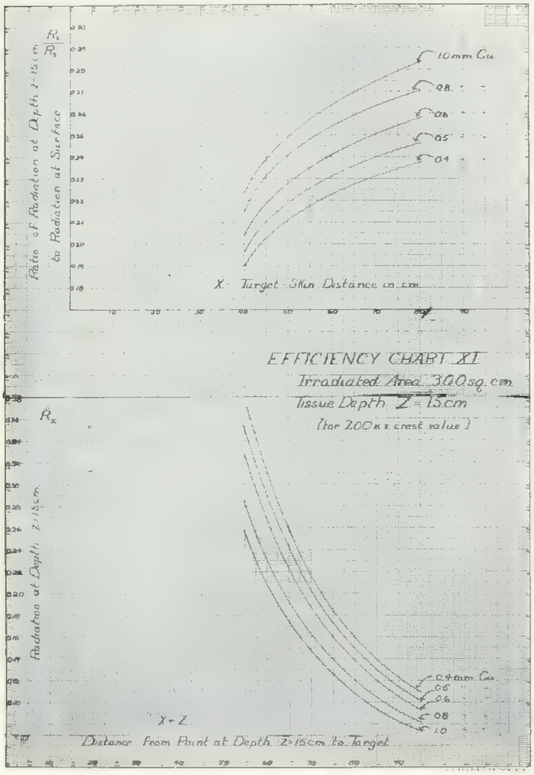


Chart XI.

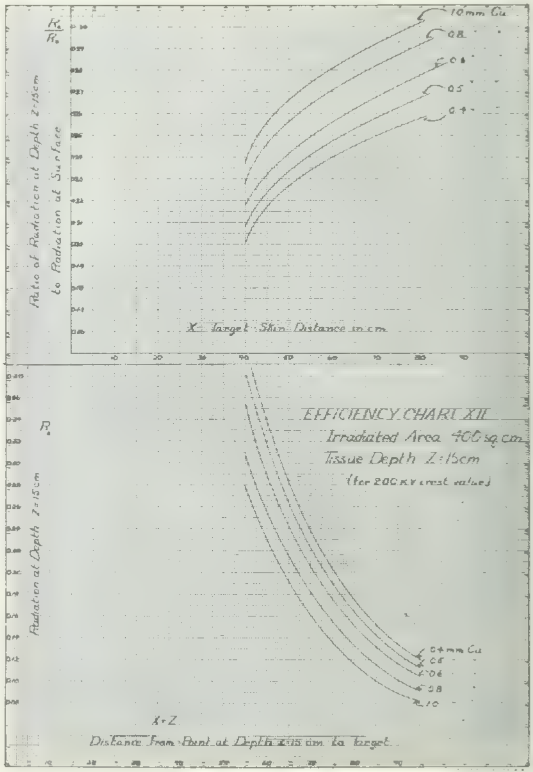


Chart XII.

There is an important point we wish to mention concerning the results which we get either from the equation or from the charts. It will be remembered that the experimental work was done with a water-phantom 30 × 35 × 30 cm. The results, therefore, are based on this volume of water as the absorbing and scattering medium. If in practice we use a smaller volume we cannot expect to apply these results without introducing a substantial error in extreme cases. For instance, in treating an arm, where the volume is small, the actual dose delivered at the center would be somewhat smaller than the data given in this paper would indicate. Radiologists have been using paraffin, beeswax, dough, water bags, etc. to increase the scattering medium in such cases and thus increase the depth dose. We recommend a similar procedure, for the additional reason that the conditions then will approach more closely experimental conditions. For this purpose the volume should be built up to approximately the 30 × 35 ×30 cm. water-phantom. A convenient way of doing this is to have a frame into which the limb to be treated may be placed. Then the desired volume can be obtained by means of rubber bags containing water. The bulk of the volume may be built up with large bags and the intermediate spaces with rubber balloons only partly filled with water.

SUMMARY

1. The ionization experiments described in this paper were made with an ionization chamber fulfilling the requirements set forth by Friedrich.

2. Precautions were taken to avoid or correct for errors inherent in such measurements.

3. The data obtained led to the following generalizations which to our knowledge have not been made before.

A. The effect of the size of the field on the radiation effective at any particular tissue depth is the same for all filters and all distances used in practice.

B. The effect of the filter on radiation at any particular tissue depth is the same for all skin areas and all distances used in practice.

C. If all the dosage factors except the target-skin distance are the same, the relative depth doses depend only on the inverse square law.

D. For purposes of skin dosage in radiotherapy, the inverse square law is applicable, provided the same beam of radiation is effective at the different distances considered.

4. An empirical equation is developed for the calculation of the amount of radiation effective at any tissue depth (including the surface) under different conditions of treatment.

5. Tables and charts of the factors involved are given. They are for a voltage of 200 kv. (crest value) and a typical American machine.

6. From the data available in the literature it is shown that these factors can be used by radiologists using machines of this type without introducing a large error in the calculations.

7. "Efficiency charts" for a number of conditions of treatment are given. They enable the radiologist to determine the most economical filter and target-skin distance to use in giving any particular treatment.

8. The charts can be used also for other purposes, such as the determination of the percentage depth dose, the number of ports of entry to use in order to obtain the desired depth dose, etc.

9. Examples are worked out illustrating the use of the equation and the charts.

10. The limits of applicability of the generalizations, the equation and the charts are definitely set forth. The data given extend only slightly beyond the ranges used in the experiments, so that no large errors are introduced by the extrapolations. We believe that no error greater than 5 per cent plus or minus will result from the judicious use of our data by American radiologists.

11. Results are independent of milliampere-minutes.

STUDIES ON THE BIOLOGICAL EFFECTS OF X-RAYS*

BY JAMES W. MAVOR

Union College

SCHENECTADY, NEW YORK

A SURVEY of the literature on the biological effects of *x*-rays shows that most investigators have used the methods of the histologist and the pathologist. It is clear, however, that disturbances which bring about directly observable changes in cells are usually of a rather gross nature and that the more delicate functions of cell parts cannot easily be investigated by such methods. In the investigations to be described a much more delicate method has been applied. The recent advances in the study of heredity have placed a new tool in the hands of the student of cellular physiology. With only a few exceptions the biologist has hitherto been limited to the observation of the reactions of the nucleus as a whole, and has had little or no opportunity to investigate the functions of its component parts.

Perhaps the most striking of the biological effects of *x*-rays is their effect on the chromatin of the nucleus. This chromatin forms the main constituent of the chromosomes. That the chromosomes determine at least some of the hereditary characters is now beyond doubt. Such hereditary characters provide a method of "labeling" a chromosome, and the behavior of such a character in heredity provides a certain indication of the functional activity of the corresponding chromosome. This new method has been applied to the study of the biological effects of *x*-rays. The experiments have been planned to show the physiological rather than the anatomical effects of the *x*-rays, and it is thought that the physiological effect is the primary one and offers the most delicate test of the reaction of the cell to *x*-rays. It is believed that the effects of *x*-rays on the chromosomes are of such a fundamental nature that they will be found to correspond throughout the animal kingdom, and therefore that the experimental animal may be chosen with reference only to its suitability for the experiments and without reference to its place in the animal kingdom.

When the investigations were first contemplated, a careful search was made for the most suitable biological material for *x*-ray experimentation. The fruit-fly, Drosophila melanogaster, was chosen. It is an animal the biology of which is well known. It is easily handled, can be conveniently bred in large numbers and has a short life-history. Its small size makes it particularly suitable for *x*-ray work, since for ordinary voltages (50,000 and over) all parts of its body receive approximately equal radiation.

The fruit flies are easily reared on fermenting banana jelly in small bottles. Starting in the egg, they pass through a larval stage lasting about five days. After this they become pupae and complete their metamorphosis into adult flies about ten days after the eggs from which they hatched were laid. The males are easily distinguished from the females, and by isolating pupae it is possible to mate the flies in pairs and thus to get exact counts of their offspring and to follow a given generation through its life-cycle.

The *x*-ray treatment was given with a Coolidge tube with tungsten target. In most cases this was water cooled. The voltage through the tube was always the same: 50,000. The *x*-rays were practically unfiltered, having to pass through only the glass of the *x*-ray tube, the air, and a single thickness of thin paper covering the small glass cups in which the flies were contained (Fig. 1) except when the flies were shielded from static electricity by placing them in a grounded lead box covered with aluminum three mills in thickness. In the latter case the *x*-rays had also to pass through the aluminum. The current passing through the *x*-ray tube varied with the experiment from a maximum of 50 ma. to a minimum of 1 ma. The distance likewise varied from 6.5 cm. to 70 cm. and the duration of the exposure from three minutes to twenty hours and twenty minutes. Since the voltage was in every case the same, in specifying the dose it is only necessary to give the intensity and the duration. A dose corresponding to 1 ma. of current through the tube, received at a distance of 10 cm. from the target and lasting for one minute, was taken as a unit and represented by D. The number of the units, D, in any of the doses used is therefore represented by the formula:

---

* This is an abstract, and no references to the literature are here given. A complete list of the literature pertaining to the investigations is given in the detailed paper. The author of this paper was awarded third prize, $200.00, in the Leonard Prize contest.

$$\frac{\text{milliamperes} \times \text{exposure in minutes}}{(\text{focal distance in decimeters})^2}$$

The first investigation was a determination of the resistance of the fly to *x*-rays at the various stages of its life cycle. A dose which was just sufficient to kill 50 per cent of the animals at the end of five days was taken as the measure of the resistance. A more accurate result is obtained by taking the dose to kill 50 per cent rather than the dose to kill all, since in the case of all being killed the dose must be sufficient to kill the most resistant, and is therefore a measure of the resistance of that fly only, while in the case of 50 per cent being killed the dose represents approximately the average resistance.

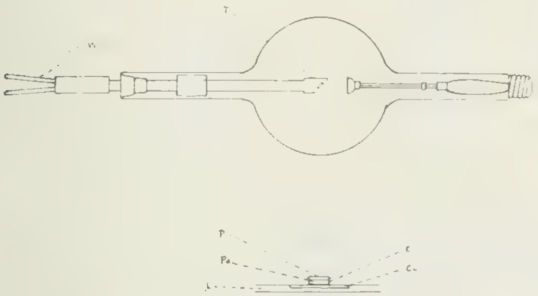


Fig. 1. Diagram of arrangement of apparatus used in the third series of *x*-ray experiments with drosophila.

The results of this investigation are represented in the graph (Fig. 2). In the case of the embryo, 50 per cent were killed in five days by a dose of 8 D (50 ma., 1 min., 25 cm.). The resistance gradually increases with age until during the latter half of the larval period a dose of 32 D is required to kill 50 per cent in five days. At the beginning of pupation there is a slight drop in the resistance followed by a sudden increase until at the time of emergence of the adult fly a dose of 630 D is required to kill 50 per cent in five days. It was necessary to obtain this data as a foundation for further work on the fruit fly. Incidentally the data show that the resistance of the fly increases with its metamorphosis and is very great in the adult fly. From this point of view the data provides another instance of the well-known theorem that actively growing and undifferentiated tissue is the most sensitive to radiation while tissue which has become stationary in its growth processes and fully differentiated is the most resistant. Experiments were also made in which the flies were reared at different temperatures. When due allowance is made for the shorter or longer periods of development at those temperatures the effect is found to be the same for the same dose. By breeding the flies treated in the above experiments the sterilization dose was determined. It was found to be approximately 50 D for the female.

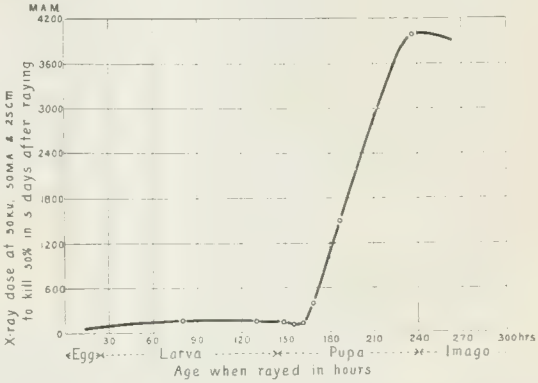


Fig. 2. Graph showing variation with age of resistance to *x*-ray in drosophila.

Since the experiments which follow deal with the effect of *x*-rays on the germ cells it will be well to review briefly what is known of the phenomena of reproduction in the fruit fly, filling in the gaps from our knowledge of the phenomena in other insects. The eggs are arranged in the ovaries in series (Fig. 3) there being about twenty such series in each ovary. In any one series the eggs nearest the oviduct are more nearly mature than those farther from it. At any one time there are from twenty to forty eggs in the same stage of the maturation process. A somewhat similar condition occurs in the case of the testis. There the stages in the development of the spermatozoa are arranged in series in such a way that the more advanced stages occur nearest to the ducts.

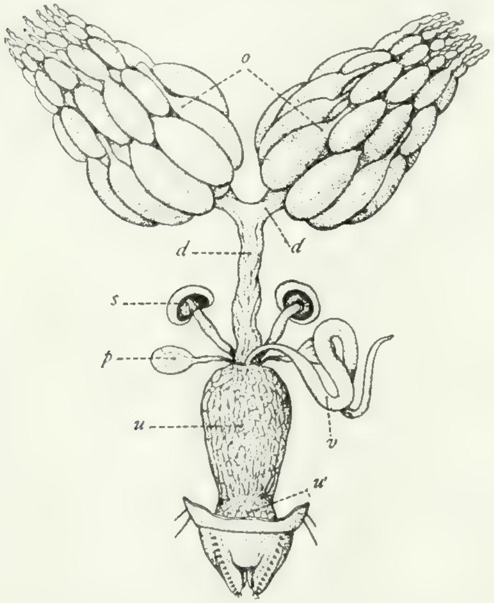


Fig. 3. Female generative organs of drosophila. d. oviducts; o. ovaries; s. spermathecae; u. uterus. After Nonidez.

The effect of radium rays on the testis of a locust has been investigated by Mohr and two of his illustrations are reproduced in Figure 4. This insect is especially favorable for the study of the germ cells. The figure shows very clearly that the radium rays affected only cells in certain stages of development. In the testis the primitive germ cells or spermatogonia continue to multiply throughout the life of the animal. The process of spermatogenesis by which spermatozoa are formed from the spermatogonia begins as the animal approaches maturity and continues during the rest of its life. In spermatogenesis, a period during which the spermatogonia, now called primary spermatocytes, enlarge in size and the chromosomes become associated in pairs, called the growth period, is followed by the maturation period in which there are two cell divisions. The chromosomes are small bodies of characteristic size and shape which occur in the nuclei of all the cells in the animal. The number, size and shape of the chromosomes in the nuclei of the body cells or primitive germ cells of any species of animal is constant and whenever such a cell divides the chromosomes divide. During the maturation divisions, however, the number of chromosomes in a cell becomes halved, owing to the fact that in the primary spermatocytes, referred to above, the chromosomes become associated in pairs and at the first maturation division the members of these pairs simply separate, one member going to each of the secondary spermatocytes which then contains the equivalent of only half the chromosomes of a body cell or primary germ cell. Since the chromosomes divide at the second maturation division the mature sperm have also half the chromosomes contained in the primitive germ cell.

Mohr's work on the locust and less clearly the work of other investigators on different animals, including mammals, shows that the stage in the development of the spermatozoa in the testis which is most susceptible to *x*-rays is the one referred to as the growth period during which the chromosomes become arranged in pairs previous to the first maturation division.

The processes by which a mature egg is formed from a primitive germ cell are exactly similar to those described as occurring in the development of the spermatozoa, there being a period of increase in size and pairing of the chromosomes followed by two maturation divisions during which the number of chromosomes in the cell is halved. The work of the writer on the fruit fly shows that in the case of the development of the egg, as in that of the sperm, the most sensitive stage is probably also the growth period during which the chromosomes are paired, although the period of the two maturation divisions is almost but not quite as sensitive. When virgin females of the fruit fly are treated with *x*-rays (50 ma., 3 min., 15 sec., 25 cm.) they produce a few offspring at the beginning of the normal reproductive period and then are sterile for a period (5 to 6 days) corresponding to the period elapsing between the beginning of the growth period and the formation of the mature egg. The studies on crossing over to be described later show that the beginning of the growth period is probably the most sensitive stage in the ovary.

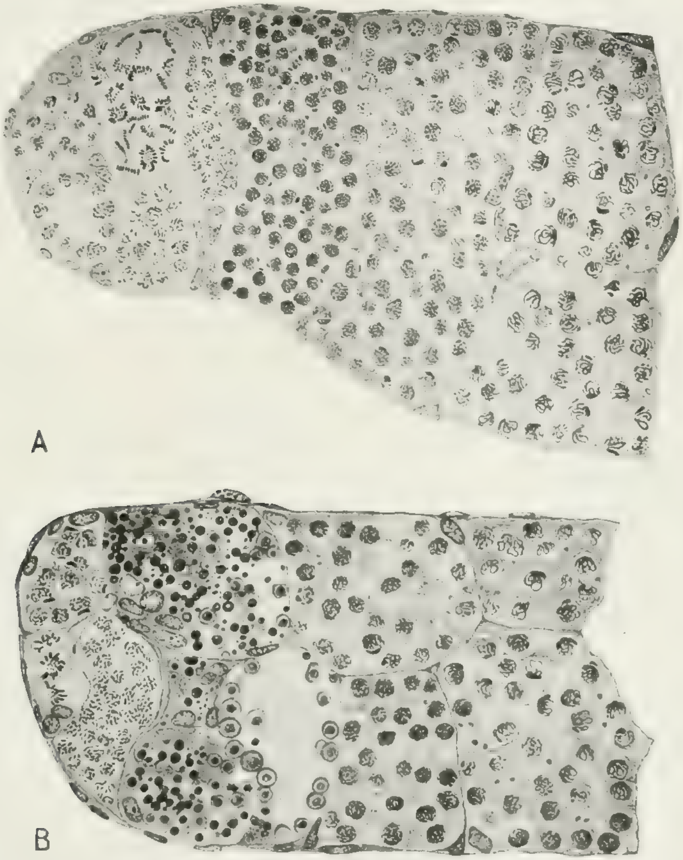


Fig. 4. Longitudinal sections through testes of Dectitus. A. normal testis from control; B. testis from individual treated with radium. Note that the region of the testis affected is that occupied by the early stages of the primary spermatocytes. The nuclei of these cells in the irradiated testis are represented by black bodies of irregular size and the cytoplasm is in some cases completely disintegrated. After Mohr.

There is a considerable body of evidence to show that the chromosomes are particularly susceptible to *x*-rays. It becomes, therefore, of importance to discover just how they are affected and at what stage. The next series of experiments by the writer throws light on this question. In order to explain the method of experimentation it is necessary to add somewhat to the description already given of the development of the germ cells. In the male fruit fly it has been found that all the pairs (in this case four) of chromosomes in the body cells and primitive germ cells are not composed of equal partners, there being one pair in which they are markedly different (Fig. 5). These chromosomes are called the X and Y chromosomes. During the process of spermatogenesis these chromosomes become separated so that half of the spermatozoa contain one X chromosome and half one Y chromosome. In the female the case is different, the place of the Y chromosome being taken by an X chromosome so that there is a perfect pair in this sex and each mature egg contains one X chromosome. When an egg is fertilized by a sperm containing an X chromosome it develops into a female and when it is fertilized by a sperm containing a Y chromosome it develops into a male.

Through the extensive work on heredity in this species of fly it is possible to associate with the X chromosome certain definite and easily recognizable characters in the adult. It is therefore possible to treat the eggs of these flies (which is done by treating the entire adult female) with *x*-rays and by an examination of the flies which develop to determine the presence or absence of the X chromosome. Such was the plan of the experiments of the writer, and they have shown that *x*-rays when applied to the egg during the process of oogenesis may cause either the elimination of the X chromosome from the egg, in which case an egg without any X chromosome is formed, or the inclusion of two X chromosomes in one egg. When these eggs are fertilized they are viable and develop into exceptional offspring which may be recognized by their inherited characters. When an egg containing no X chromosome is fertilized by a sperm containing an X chromosome it develops into a male, while ordinarily an egg fertilized by a sperm containing an X chromosome gives rise to a female. When an egg containing two X chromosomes is fertilized by a sperm containing a Y chromosome it develops into a female, while ordinarily an egg fertilized by a sperm containing a Y chromosome gives rise to a male. Such females are exceptional in their inherited characters and in most cases are fertile and give rise themselves to exceptional offspring, so that the exceptional condition is inherited. The relation between the time at which the *x*-ray treatment was given and the time at which the exceptional males and females were produced is of great interest. This is shown for the males in the graph (Fig. 6). It will be noticed that the exceptional flies are produced during one of two periods, either one to three days after the treatment or five to nine days after the treatment. It is possible that the first group of exceptional flies arose from eggs which were approaching the second maturation division and that those of the second group arose from eggs which were approaching the first maturation division at the time of the treatment. It is not necessary to assume a latent period in this action of the *x*-rays. Indeed it is improbable that any considerable time elapses between the time of *x*-ray treatment and the time at which the cell

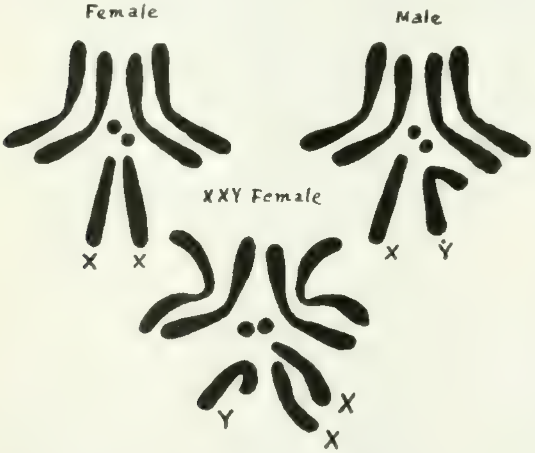


Fig. 5. Chromosomes of drosophila. Above and to the left those of the female including two X chromosomes, and to the right those of the male containing one X and one Y chromosome. Below XXY female showing the result of nondisjunction of the X chromosomes. After Bridges.

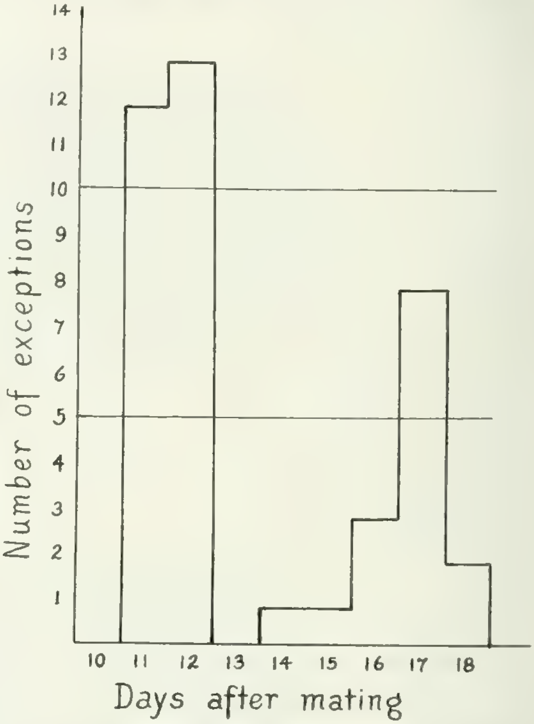


Fig. 6. Graph of time of emergence of exceptional sons of *x*-rayed females in third series of *x*-ray experiments with drosophila.

becomes modified in such a way as to produce an abnormal distribution of the chromosmes.

One important result of the experiments is the demonstration that of all parts of the cell, the hereditary material responds most easily to the effects of *x*-ray treatment. This is made clear by the fact that the exceptional flies which develop from the *x*-rayed eggs are normal in every way except their hereditary behavior. It is possible that we see here the nearest approach to a specific effect of *x*-rays yet discovered since no other physical or chemical agent which produces this effect is at present known. The series of experiments shows that there is in the effect of *x*-rays on the germ cells a very clear case of an external agent which modifies the mechan ism of inheritance in such a way that a permanent effect is produced which is transmitted through successive generations.

In another series of experiments a still more delicate method has been used to test the effect of *x*-rays on the chromosomes. It is found that in the female the chromosomes of any one pair may interchange the character determiners which they carry. Thus one chromosome of a pair (in this case an X chromosome) may be known to carry the determiners for eosin eye color and miniature wings, and the other chromosome of the pair the alternative normal characters corresponding to these, namely, red eye color and normal wings. These chromosomes may interchange characters so that one contains the determiners for eosin eye color and normal wings and the other the determiners for red eye color and miniature wings. Under natural conditions the frequency of this exchange is quite definite and the per cent of cases in which it occurs is called the crossover value of the characters concerned. The interchange in all probably occurs during the synapsis stage. It is believed to depend on some physical property of the chromosomes.

Experiments were devised to test the effect of *x*-rays on the crossover value both in the case of the X or sex chromosome and the second pair of chromosomes. In the case of the X chromosomes it was found that *x*-ray treatment decreases the amount of interchange or the crossover value, as it is called. In the particular case investigated the normal crossover value was 30 and after *x*-ray treatment was reduced to 10. The experiment was made of varying the duration of the dose while keeping the dose itself (intensity × time) constant. It was found that within a factor of 375 (3 min. 15 sec. and 20 hrs. 20 min.) no difference could be observed. Since the effect of the *x*-ray treatment on the interchange of the hereditary determiners was evident over a relatively long period (six days) and the interchange itself occupies a shorter time, the experiments show that the effect of the *x*-ray treatment is not directly on the process of interchange, but rather on the physical condition of the chromosomes or the surrounding protoplasm. There is a large body of evidence which goes to show that the hereditary determiners are arranged in the chromosomes in a linear series and that the interchange of these determiners between the chromosomes is due to the two chromosomes of a pair breaking at corresponding points and interchanging corresponding parts. It has been shown that temperature affects the amount of interchange (crossing over) in the second chromosome and that temperature does not affect the amount of interchange in the X chromosome. It is, therefore, probable that in the effect of *x*-rays on the interchange of hereditary determiners in the X chromosomes there is a specific effect of *x*-rays, since all other attempts to produce the same effect by using other physical and chemical agents have failed.

Experiments were also carried out on the effect of *x*-rays on the interchange of hereditary determiners located in the second pair of chromosomes. In this case the *x*-ray treatment was found to increase the amount of interchange. In one of the cases included in the experiments a normal crossover value of approximately 5 was increased by *x*-ray treatment to approximately 25. It was also found that the *x*-rays affect to a different extent the interchange in different parts of the second chromosome.

It should be emphasized that while certain theories regarding the mechanism of inheritance have been used to explain the results of the *x*-ray experiments, the results themselves depend in no way on any assumptions regarding the mechanism of inheritance, but entirely on the statistical findings of experiments. The general results of the experiments may be summarized as follows:

1. A curve showing the variation of susceptibility to *x*-rays with age in the fruit fly, Drosophila, has been obtained. This curve shows a sudden decrease in susceptibility during the latter part of metamorphosis, that is, after the main structure of the adult fly has been laid down.
2. The sterilizing dose of *x*-rays is small compared to the lethal dose for the adult fly. A dose can be found which gives temporary sterilization. In this case the mature eggs are still fertile, the sterile period beginning after their deposition.
3. The experiments show that *x*-ray treatment affects the distribution of the chromosomes during the maturation of the egg, and that such eggs, although their structure has been altered by the *x*-rays, may nevertheless develop into adult flies and produce offspring.
4. The effect of the *x*-rays, consisting in an irregular distribution of the chromosomes, is inherited.
5. *X*-rays may cause a modification in the interchange of hereditary determiners between chromosomes. The effect of the same dose is not the same in each of the pairs of chromosomes nor in the different parts of any one pair of chromosomes. In the first or X chromosomes the amount of interchange is decreased, while in the second pair of chromosomes it is increased.
6. The effect of *x*-rays on the interchange of hereditary determiners is not directly on the process of interchange but on the chromosomes or the protoplasm surrounding them.
7. The duration of the *x*-ray treatment for the modification of the interchange of hereditary characters is immaterial provided the product, intensity × time, is kept constant.
8. Reasons are given for considering that certain of the effects of *x*-rays on the mechanism of inheritance are specific.

It is perhaps premature to discuss the bearing of these results on the practical use of *x*-rays. Certain points may, however, be noted. The experiments show that *x*-rays provide the first really practical and universally applicable method of modifying inheritance. In this respect *x*-rays will probably prove of great value in the study of heredity, and this study will in turn throw further light on the biological effects of *x*-rays. Whether *x*-rays will ever be applied to modify inheritance for practical purposes, for example, in agriculture, is a question.

It is known that the mechanism of inheritance in man is, at least in its main outlines, identical with that which occurs in the fly and other animals. The behavior of the chromosomes is the same and there is an uneven pair. Hereditary characters, such as color-blindness and hemophilia, behave in a manner precisely similar to the characters located in the X chromosomes of the fruit fly. The results, therefore, so far as they go, are directly applicable to the human subject. It is of course highly improbable that *x*-rays will ever be used intentionally to modify human inheritance. However, with the present use of *x*-rays both therapeutically and for the production of temporary sterilization it is not unlikely that modifications may be produced, especially as we already know of a number of cases of children born of mothers whose generative organs had received *x*-ray treatment.

It is believed, however, that it is not in the field of heredity that these results will be found to be of the greatest significance. The methods used in these experiments to test for biological effects of *x*-rays are undoubtedly much more delicate and far-reaching than any hitherto applied. These methods provide a means of analyzing the effects of *x*-rays on cells. They show how *x*-rays may produce a permanent change in a cell without altering its vitality. A method of experimentation has been developed indicating lines of further investigation which may help toward a clear understanding of the exact physical and chemical changes produced by *x*-rays in living protoplasm.

THE OCCURRENCE OF TWO HERITABLE TYPES OF ABNORMALITY AMONG THE DESCENDANTS OF X-RAYED MICE*

BY

C. C. LITTLE, SC.D.
Carnegie Institution of Washington
and University of Maine
ORONO, MAINE

AND

H. J. BAGG, PH.D.
Huntington Fund for Cancer Research
Memorial Hospital, and Cornell
University Medical College
NEW YORK CITY

INTRODUCTORY

FOR years attempts have been made to modify the germ plasm of a living organism. Various agents have been employed, many chemical, many purely physical. Among the latter, radioactive substances such as radium or mesothorium have been utilized. Roentgen rays have also been used. The object of this communication is to present a simple experiment in the application of *x*-rays to adult mice, together with a study of the appearance and inheritance of two peculiar types of abnormality among the descendants of the animals so treated.

The two types of abnormality described are striking, and, for the most part, unfavorable to the animals possessing them. The situation is therefore of interest, not only to students of heredity, but also to medical men interested in the theory or practice of roentgen-ray therapy.

It will be well to state at the outset that no far-reaching claim or assertion is made on the basis of the facts here presented. The situation is merely one of clear and characteristic new forms, and, occurring as they do in a mammal, they should, we feel, prove a source of speculation to all those to whom the great possibilities of the physical agents as modifying elements in biology or medicine have made their appeal.

Two main facts are of prime importance to any experiment with *x*-rays. These are the family and case histories of the individuals used, and the amount and nature of the radiation to which they were subjected.

History of Stock of Mice Used. For the benefit of the reader who has not followed in detail the development of genetics during the past two decades, it should be noted that mice are to be looked upon as, in a way, the pioneers among mammalian material used for experimental breeding. The hereditary behavior of more than one hundred color varieties is known and has been carefully recorded. Numerous investigators have for years been studying and placing on file data of the methods of inheritance of their morphological, physiological and psychological traits The result naturally is that *new* variations—new abnormalities—are clearly recognizable and can at once be compared with all known types in existence.

The race or stock used in this experiment was composed of brown mice, a race which for some years had been carried on as a fancy pen or strain of poultry would be, without the introduction of any new blood. They were therefore sufficiently inbred to have given ample opportunity for the cropping out of any latent defects of the types to be described. The failure of such abnormalities to appear in the stock either before treatment with *x*-rays or in the 2,000 control animals from the same stock while under close observation and study, forms strong evidence that the *x*-rays themselves were the agent that actually brought about the changes producing the abnormalities.

History of the Individuals Used. Four female and three male mice, all adults, were used in the experiment described. None of the females were pregnant at the time of exposure. The numbers (for identification) of the females were 83, 84, 85 and 86; and of the males, 36, 40 and 42. The mice were in good health at the time of exposure and remained so afterward. They did not, however, produce any young until more than ten weeks after radiation. This seems to indicate clearly

---

* The authors of this paper were awarded honorary mention in the Leonard Prize contest.

(1) that none of the young descended from them could have been in utero during the exposure (the gestation period being approximately twenty-one days) and (2) that the estrous cycle and process of ovulation was badly disturbed, or that it was normal but that several of the ovulations following exposure produced only dead or impotent eggs, or that the vaginal or uterine secretions were so altered by radiation that no sperm could survive long enough to reach the ova.

Unfortunately the males were not separately tested, and it is not possible, therefore, to say whether they were affected or not. Since the exposure, however, was dorsal and the testes were well protected from above by their ventral position, it seems much more likely that the ovaries were, of the two types of gonads, the more readily reached, and therefore the more easily modified.

Exposure. The dosage was of twelve seconds' duration on each of five successive days. The target skin distance was 12 in.; the milliamperage 10; the spark-gap 2½ in. No filter was used. The whole amounted to ⅕ of a human erythemal dose given over the whole dorsal surface of the animal on each of five successive days. Other groups of animals received heavier doses, but need not be described here. As before stated, the treated mice showed no ill effects other than the temporary slowing down of breeding already mentioned. Leaving now the account of the experimental animals, let us, before describing their descendants, examine very briefly the work done by other investigators while trying to modify the germ plasm with *x*-rays, or to test their direct effects.

HISTORICAL

Attempts to modify the germ plasm by the use of *x*-rays, radium, or other radioactive substances have been fairly frequent. The peculiar action of rays on protoplasm and their great possibilities as modifying agents of its normal processes are nowhere more clearly shown than by the series of experiments by Oscar, Guenther, and Paula Hertwig on the eggs and sperms of aquatic forms.

Among other things, they were able to demonstrate what amounted to a selective action of radium rays on the nucleus or nuclear material of the sperms and unfertilized eggs of frogs. When medium doses of radiation were used and the treated sex cell was fertilized by a normal untreated sex cell of the opposite sex, the resulting larva was deformed, abnormal and not particularly viable. When, however, a heavier dose was used, the nucleus of the sex cell was completely prevented from participating in cell division and development. An embryo was formed consisting of the nucleus of the untreated cell and the cytoplasm of both sex cells, such as it was. In these cases the embryos, which, as can be seen, were in a way pseudoparthenogenetic, developed normally but were of a smaller size than the control embryos neither of whose ancestral sex cells had been treated by radiation.

This work does not prove the modification of the germ plasm within the soma to be possible. Neither does it attempt to test whether these abnormalities induced by the direct exposure of sex cells are inherited. It does, however, show that direct exposure of sex cells may result in modifying the nuclei of these cells in such a way as to produce abnormal individuals.

Fraenkel has reported on a small series of experiments with *x*-rays on guinea-pigs. He found that the effect of exposure differed in young and old animals. Thus, in adults there was a marked difference in the surface of the ovaries. That of the control was covered with protuberances, the Graafian follicles, while in the treated animals these had completely disappeared. By using pregnancy as a test, he was able to conclude that radiation of young animals slowed down the growth rate, but that in such animals pregnancy occurred proportionately much sooner after treatment than in the case of radiated adults. It is interesting to note in passing that none of the treated mice in our experiments produced young for at least ten weeks after treatment. They were adults of reproductive age when treated and the result parallels closely, therefore, that described by Fraenkel. The rays in his experiment were applied from the direction of the head vertically through the body. The few young which were obtained from exposed animals were undersized. They also possessed bald spots in the same regions as those which became bald in the exposed animals themselves. He considers this to be a case of inheritance of an acquired character. As before stated, his numbers are too small to be conclusive, and *true* inheritance as such is not proven because he uses treated females, and the possibility of the transmission of a direct cytoplasmic change cannot be disregarded and is most certainly to be considered until eliminated.

In a paper reported at the Christmas meetings of the American Society of Zoologists at Boston (1922) Hanson describes the preliminary results of a series of experiments with *x*-rays on rats. For the most part, the effects which he describes are the result of direct radiation of animals in utero. In several animals so treated a few days before their birth, serious eye defects, hemorrhage of the brain, paralysis and sterility are among the results noted. It is interesting to note that Bagg found that both rats and mice treated with radium while in utero showed eye abnormalities and distinct nervous symptoms, tremors, and various degrees of ataxia.

Both these series of results suggest the interesting similarity between the conditions found in treatment in utero and those observed in certain of the descendants of *x*-rayed adult animals reported in this paper.

Two other experiments may be briefly cited as showing perhaps more clearly an upset of a definite sort in the internal organization of the sex cell. The first of these is the work done by Mavor on the fruit fly, Drosophila melanogaster. Here the cytology and genetic constitution of the types used have been well worked out. It has been clearly shown that a certain group of hereditary characters are either carried in or depend for their expression upon a particular chromosome. Mavor treated young female flies with *x*-rays and found in their offspring an unusually high proportion of cases involving abnormal distribution of the halves of a particular chromosome at maturation. The effect was that in many cases this chromosome failed to divide, with the result that the egg cell either had a double representation of the chromosome or else failed to receive it at all. The tendency to excessive abnormalities in the distribution of the chromosome in question was handed on for several generations.

Blakeslee and Gager working with the jimson weed, Datura stramonium, found a somewhat similar increase in the appearance of abnormalities in chromosome distribution following treatment with radium. They reported on this work at the Christmas meeting of the A. A. A. S., 1922. They had not carried the work far enough to determine whether the abnormalities so produced were going to be handed down to the descendants of the treated plants.

With these various facts in mind, it is not surprising that the use of physical agents should be suggested as a promising means of trying to reach into the germ cells and there upsetting the normal type of organization by a new one that is self-perpetuating by inheritance.

DESCRIPTION OF EYE ABNORMALITIES[1]

Drawings and photographs of animals showing this particular type of eye abnormality are shown in Figures 1 to 15 inclusive. In describing the abnormality it has been spoken of as one involving the eye alone. This, however, is far from being the case. A moment's consideration of Figures 9, 13, 14 and 15 will show clearly other regions that are definitely abnormal. Thus Figures 9, 13 and 14 show a fairly common expression of the abnormality. This type is acephalic and also extremely pale in color. Such animals are born dead. Usually by the time they are discovered in or near the nest, they have had all the brain or other material within the cranial cavity removed by their mother. In one case, however, we obtained such a young mouse so soon after birth that its mother did not have time to begin the process. This mouse had a clear lesion of the cranial region with a dried crusty scab on the surface. The cranial cavity seemed filled with fluid giving a rather marked hydrocephaly. It is undoubtedly true that the other mice of this "pale fetus" type had similar lesions.

---

[1] It is customary in genetics to give each inheritable character the heredity of which has been investigated, a letter by which to designate it. This letter is used in expressing its formula as regards mendelian inheritance. The letter is given here merely to make identification of the character easy in connection with other publications in which it may be used.

Figure 15 shows another modification of the abnormality. In this case the upper jaw has been shortened and twisted upward producing a "bull-dog" mouse. Animals of this general type, but somewhat less extreme than the individual figured, have survived for a considerable period of time.

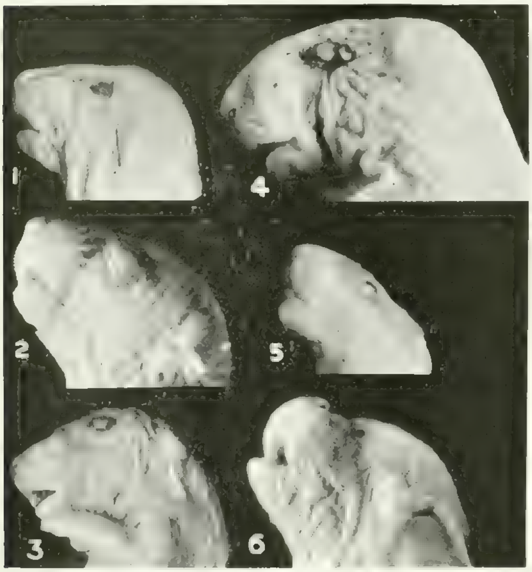


Fig. 1. Mouse 2068. A photograph of a day-old mouse preserved in 10 per cent formalin. The abnormal eye is clearly visible. It is a scabbed lesion of the type shown in Mouse 8597 (Fig. 13) except for the fact that the iris pigment and the lens do not show.

Fig. 2. Normal mouse showing the raised skin covering the eyeball with no sign of any external lesion.

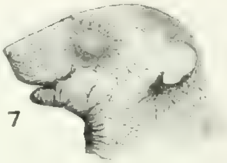
Fig. 3. No. 2071. Clearly abnormal eye much like Mouse 9585 (Fig. 13). The lens appears as the light body surrounded by scabbed area and the iris pigment. The lesion covers the entire eyeball.

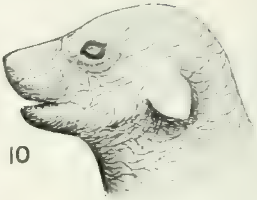
Fig. 4. Mouse 8621. Fig. 5. Mouse 2053. Typical pale fetuses of the same type as 9147 (Fig. 15). Note that in these cases, as in that, the entire cranial area, probably hydrocephalic in nature, has been removed by the mother mouse. The eyes are clearly dried and abnormal.

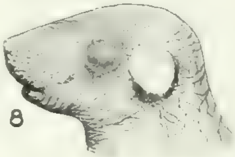
Fig. 6. Mouse 8670. A peculiar type in which the eye lesion is clear and in which the face is twisted and deformed, giving what may be called a "bull-dog" appearance. Several such mice have been recorded.

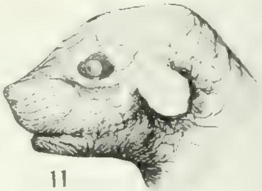
In such mice the teeth are not normally situated, being irregular in direction of growth as well as position.

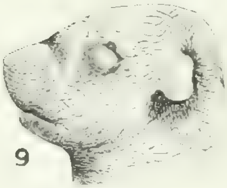
Bagg, who has made a particular study of the structure of the brain of the abnormal-eyed mice, has in press a paper dealing


7


10


8


11


9

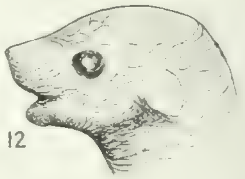

12

Fig. 7. 6591. Normal-eyed albino. Note that the skin over the eyeball is unbroken and smooth. There is no pigmentation visible. The eye is regular in shape and of normal size.

Fig. 8. 8550. Normal-eyed brown. Note that the appearance is very similar to 6591 (Fig. 7) but that the ring of iris pigment is slightly visible under the unbroken skin which covers the whole eyeball.

Fig. 9. 9490. Shows a very slight degree of abnormality. For the most part, the skin over the eyeball remains unbroken as in the foregoing examples. Just superior to the upper part of the eyeball there is a small lesion, dried and scabbed over with a crusted exudate, probably of non-inflammatory origin. Note the peculiar shortened foreface which this animal possesses. There is much variation in the length and type of foreface. The animal in question deviates much more from the normal type in this regard than in the eye lesion itself.

Fig. 10. 6589. A more clearly advanced case of a type of abnormality similar to 9490 (Fig. 9). Here the lesion is larger. The eye is more generally affected. It has become shrivelled and dried. In the center of the scabbed area is a crystalline structure, opaque and almost spherical. This is undoubtedly the lens, which, because of its durable nature, has not been modified fundamentally during the disarrangement of the rest of the eye.

Fig. 11. 7528. An abnormality of larger area, but less fundamental nature, than 6589 (Fig. 10). Here there is a large, irregular scabbed area, in which is situated the lens. Such an eye, as is the case with all these abnormals, is undoubtedly non-functional.

Fig. 12. 9585. An example of a much more extensive development of the abnormality. The whole eye is dried and laid bare by a lesion which removes the skin over the whole eyball. The iris pigment seems dried and condensed, giving a more concentrated appearance. The lens is present as in the other cases, lying on the surface, although somewhat imbedded in the dried, scabbed area surrounding it.

with this matter. It is, however, of interest to note, in passing, that in abnormal-eyed mice, degeneration has occurred in one or both of the optic nerves, and that other structural changes and abnormalities of a fundamental nature take place.

In the eye itself there are many degrees or grades of abnormality. An effort has been made to bring out in the figures some of the common types. In almost all abnormal-eyed young there is at birth a clear lesion in the region of the eye. These lesions vary in depth and extent. Rarely, instead of an actual external lesion, the eye presents a sunken and shrunken appearance. The eye is greatly reduced in size in such animals. As an animal of this type grows older the sunken eye either fails to increase in size or degenerates still further, producing a depression and, of course, complete blindness of the eye in question.

In eyes showing a lesion, degeneration of the eye elements themselves has proceeded to different degrees. Thus, in some cases, the eye is almost normal, with the exception that the lens is clouded or entirely opaque and there may be slight reduction in size of the eye as a whole. The eyes of some of the mice of this type present a marked degree of similarity to certain of the eyes obtained by Bagg after in-utero treatment of rats with radium.

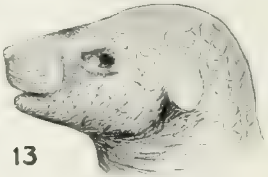
Many other types are to be found. One with a minute scabbed lesion just above the eye is shown in Figure 3. More extensive lesions are shown in Figures 4, 5, 6, 7 and 8 in Figures 10, 12 and 15.

In each of these cases a brief description of the conditions found has been placed in the explanatory notes to the figures.

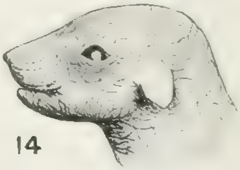
Normal Overlaps. At birth the young obtained from abnormal × abnormal matings may have the following eye conditions, in so far as superficial external appearance is concerned:

1. Both eyes clearly abnormal.
2. Both eyes slightly abnormal.
3. One eye clearly, one eye slightly abnormal.
4. One eye clearly abnormal, one eye normal.
5. One eye slightly abnormal, one eye normal.
6. Both eyes normal.

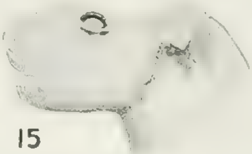
When one eye only is abnormal it may be either right or left, with apparent equal frequency. The whole situation, therefore, suggests that two variables are involved: 1. The degree to which any eye is abnormal. This runs through a graded series from a condition in which there is a clear lesion with the entire eye dried and reduced, to a condition where no external lesion or reduction is observable, the eye apparently being normal. 2. The distribution of the abnormality to both, or to one, or to neither eye, in so far as external appearances are concerned.



13



14



15

Fig. 13. 8597. An interesting modification of the abnormality. The scabbed area is large and irregular and the lens small and out of normal position, being at the lower margin of the lesion. The iris pigment seems to be in the form of a clump of a symmetrical outline at the posterior margin of the lesion. Such a type as this shows a marked disarrangement of the eye.

Fig. 14. 8464. One of the more extreme manifestations of the abnormality. The lesion is deep, and, with the exception of a small lens near the center of the lower border, filled with a pigmented scab, probably representing a combination of the iris pigment and exudate.

Fig. 15. 9147. A very typical expression of the abnormality. This has been described as "acraniate-pale fetus." The whole animal is abnormally white and bloodless. The eyes are grossly abnormal, with a deep lesion and with the lens and ring of iris pigment exposed. When found, such embryos are almost universally without a top to the skull. This defect is undoubtedly primarily due to a lesion located there, although, except in rare cases, removal of tissue in this part by the parent renders exact description of the lesion in its original form impossible. These pale fetuses are always born dead.

Variation in inheritable characters is, of course, general. It is quite common to find that in the case of morphological characters this variation leads in the direction of the normal type to a point where it is by gross examination indistinguishable from the normal itself. Examples of this type of character have been recorded by Castle (1906) in the case of polydactylism in guinea-pigs; by Wright (1916) in the rough coated character of guinea-pigs, and in several characters in birds, notably feathered legs in pigeons; by Doncaster (1912) in web feet in pigeons; by Staples Brown (1908) in syndactylism and polydactylism; and by Davenport (1906) in rumplessness in fowls.

No extensive attempt has yet been made to determine what rôle modifying genetic factors are playing in the variations of the abnormal eye character in the material under observation. It is quite possible that one or more such modifying factors may be involved, and although their isolation and identification would be difficult, it should, and when opportunity affords, will be, attempted. A certain amount of the variation will, however, in all probability, be due to internal environmental influences—the shifting balance between organs, tissues and cells during ontogeny. This must remain as a source of uncertainty until our knowledge has advanced to a point sufficient to enable us to analyze and measure processes of this sort.

At present it will suffice merely to state that the fact that normal overlaps occur is not surprising, and that no new principle in this regard is involved in the case under consideration.

The eye abnormality first appeared in a brown male mouse, No. 1369. This animal was a grandson of two animals that had been exposed to *x*-rays. His parents had not been treated. One of his eyes was distinctly abnormal and degenerate to a point of failing to function.

In a subsequent litter from the same parents a brown female, No. 1373, also abnormal in one eye, was obtained. When these two animals were bred together evidence at once began to accumulate to indicate that the eye abnormality was a recessive character. From results later procured it became apparent that Male 1369 also carried the potentiality of giving progeny with abnormal feet. A more detailed treatment of the inheritance of these abnormalities will be found in a later section.

Although breeding experiments within the family in which the eye abnormality appeared were continued, they cannot afford as good evidence of the type of inheritance involved as can an outcross with a known but unrelated stock.

TEST OF INHERITANCE

There is a simple and effective test of inheritance which is made by crossing an abnormal-eyed (hh) male with an *unrelated*, normal-eyed female (HH), and then, by inbreeding their normal (Hh) F_1 generation descendants, produce F_2 and F_3 generation hybrids. Abnormal-eyed animals of these and subsequent generations should then be bred inter se and should breed like the original abnormals.

A test of this type was made by crossing abnormal-eyed Male 1369 with females of unrelated (Bagg's albino) race. The first hybrid generation (F_1) was normal-eyed. F_2 produced by crossing F_1 inter se, and further similar crosses gave a total of 113 normals and 29 abnormals. These abnormals and those of later hybrid generations bred together gave 16 abnormal in both eyes, 116 abnormal in one eye, and 36 normal (overlaps). Those of the 36 normal overlaps that were tested by breeding gave a result similar to those which were obtained in the *x*-ray lines 85 and 86 before any outcross was made.

The test of inheritance given above insures transmission of the character in question through the sperm. The possibility of the egg cytoplasm as a carrier is eliminated by using normal-eyed females of an unrelated race as the female parents of the hybrids from which the eye abnormality was later recovered.

It is only by some such test as the above that we can surely eliminate the possibility that direct transmission rather than true inheritance is involved.

The figures given above show clearly three main facts:

1. The eye abnormality is inherited.

2. Its inheritance is essentially mendelian in behavior.

3. A certain number of animals genetically abnormal-eyed are somatically normal-eyed, so far as gross anatomy is concerned. The percentage of these in this particular cross is shown in the progeny of abnormal-eyed individuals crossed inter se. Here out of a total of 168 young, 36, or 21.4 per cent, were normal-eyed. It will be recalled that when animals carrying the abnormal eye as a recessive were crossed together, 113 normal and 29 abnormal were obtained. The expectation on a mendelian basis is 106.5 normal to 35.5 abnormal. There is observed a slight excess of normals and deficiency of abnormals. If, however, among the somatically normal, a certain number are genetically abnormal, we may make a correction, purely for the basis of comparison.[1] When this is done, the numbers are 107.5 ± normal, and 34.5 ± abnormal—very close to the 106.5 to 35.5 ratio expected.

When the results obtained in the inbred family in which the eye abnormality appeared are considered, a situation closely resembling the foregoing is observed.

In this family, almost all the matings have been of abnormal-eyed mice inter se. From such crosses, a total of 447 young has been obtained. Of these, 374 are clearly abnormal in one or both eyes, and 73, or 16.3 per cent are normal in appearance. Many of the latter have been tested by breeding, and in each case in which such a test has been made, have been found to behave genetically as abnormal. The percentage of these genetically abnormal mice that are somatically normal is then about 15.1. Crosses of normals carrying "abnormal," inter se have given 75 normal and 15 abnormal young. On a mendelian basis 67.5 normal and 22.5 abnormal are expected. If a correction to account for the difference between genetic and somatic "normals" is made, the numbers become 72.8:17.2.

In the cross of abnormal-eyed with normals carrying abnormal, where a 1:1 ratio of the two types (normal and abnormal) is expected, the observed numbers are 52 normal and 40 abnormal. The expectation is 46:46. When a correction is made, the numbers come out exactly 46±:46±.

In general then, we may conclude that the genetic behavior of this character is mendelian, and sufficiently regular to enable us to have a fair degree of definiteness in predicting its place and rate of occurrence.

THE INHERITANCE OF ABNORMAL LEGS AND FEET

In showing the nature and types of this abnormality, we are handicapped by the fact that photographic representations are not particularly satisfactory because of the minute size of the parts involved. The drawings are therefore submitted in the hope that at least a general impression may be obtained of the more common types of the abnormalities.

Figure 16 shows a foot of Mouse 6107 in which there is a discolored hemorrhagic lesion and a slight shortening of the digits. In all other respects the foot appears to be normal. It may therefore be taken as approximating the normal type and as representing a very slight degree of abnormality. The three other legs and feet of Mouse 6107 were normal.

Figure 17 goes almost to the opposite extreme and shows the three abnormal legs of mouse 6047. In these the abnormality is marked. In the left hind foot the digits are absent as separate units, the only possible indication or trace of them being slight crenulations in the edge of the stumpy shapeless leg.

On the right hind foot are three much reduced and poorly differentiated digits. There is also an irregular scabbed lesion. The digits are bent so as to be pointed in the direction of the body, the direct opposite of their normal position. On the left front foot there is a large discolored and hemorrhagic lesion and two small papilla-like nodules in place of digits. It is not clear whether they represent structures that would have developed into claws on normal digits, or whether they are the digits themselves.

---

[1] The correction can be made as follows. If among the progeny of abnormal-eyed mice crossed inter se, 16.3 per cent are normal in appearance, then for the 29 abnormal young observed there must have been formed a certain number of somatically normal, but genetically abnormal animals. The number of these cannot be exactly told. It can, however, be estimated by considering the 29 abnormal young observed as representing 83.7 per cent of the total abnormals formed. When this is done, the number left to be estimated as somatically normal and genetically abnormal is 5.5. These should, in our calculation, be subtracted from the *observed normals* and added to the observed abnormals.

Mouse 8869 is shown in Figure 18. In this case three digits are moderately well formed but are oriented peculiarly, being twisted somewhat in the manner of those shown in Figure 17.

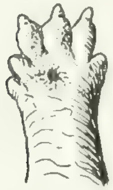


Fig. 16.

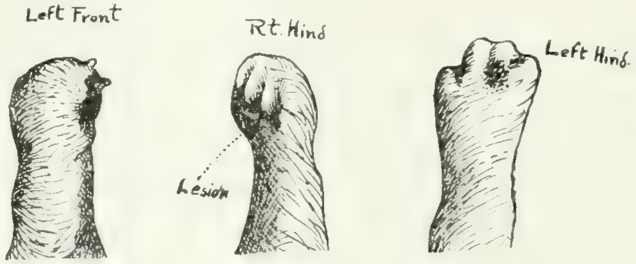


Fig. 17.

Fig. 16. Mouse 6107. A foot is shown with a slight abnormality associated with a hemorrhagic lesion.

Fig. 17. Mouse 6047. Three legs are here represented with markedly deformed digits. The abnormalities are associated with hemorrhagic lesions.

Figure 19 shows a ventral view of the posterior end of Mouse 7412. The right hind foot is shown from the ventral side and is normal. The left hind foot, however, is curled over toward the body and has no visible trace of digits. It is also almost certain that there is ankylosis, and possibly some actual deformation of the bones themselves.

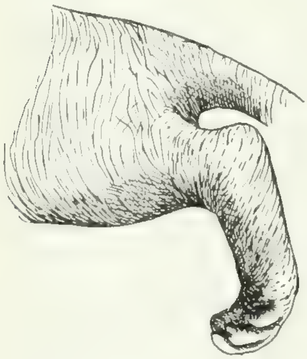


Fig. 18.

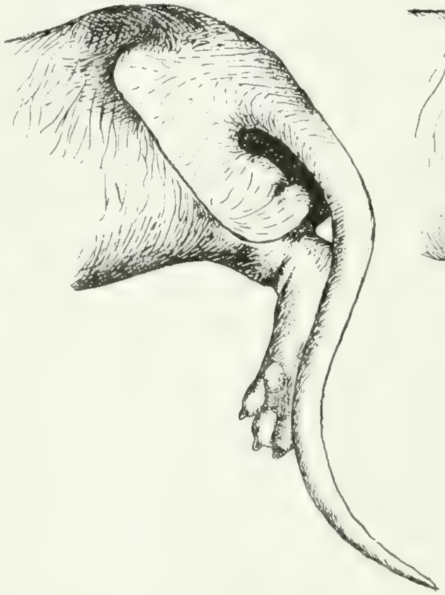


Fig. 19.

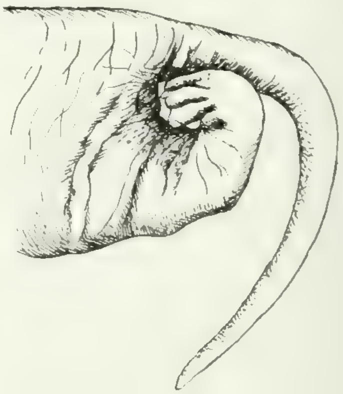


Fig. 20.

Fig. 18. Mouse 8869. The abnormality in this limb is mainly a faulty position of the digits.

Fig. 19. Mouse 7412. A ventral view of the posterior portion of the body showing an abnormally retracted and deformed left limb.

Fig. 20. Mouse 8235. Posterior portion of body showing a marked twisting and deformity of a hind limb.

Figure 20 shows a left lateral view of the posterior end of Mouse 8235. Here, although the digits are more or less clearly defined, the whole leg is badly distorted and twisted into the extraordinary position in which it is shown. Of course it is impossible to estimate on the basis of superficial appearance what the bone and joint conditions actually are in this case, but it seems certain that they are markedly abnormal.

The above descriptions, although imperfect, will serve to show that the abnormal leg condition is subject to wide variation. The breeding records shown in the various pedigrees mentioned later will further show that there are undoubtedly animals which are genetically abnormal-footed, but which somatically appear normal under a gross examination. We may now briefly consider these pedigrees, which will be found in charts I to XI inclusive.

Chart I refers in four places to Mouse 1369. This mouse has been considered several times in the section on abnormal eyes. He was the male individual outcrossed with unrelated females to provide, for that character, the test of true inheritance. The same crosses which were made in that case serve as well to provide the test of true inheritance for abnormal feet. Those in Chart I are the progeny of Female 2672 and Male 1739, and have among them 1 abnormal-footed animal. The further generations from that cross have actually 7 abnormal-footed individuals. The second line of the same chart shows the progeny obtained from crossing Female 1367 with her brother, Male 1369, and demonstrates clearly that he carried the tendency to produce abnormal-footed individuals. Since foot abnormalities have never appeared in the Bagg albino stock which was the parent stock for the outcross, it seems clear that Male 1369 introduced the abnormality in the outcross.

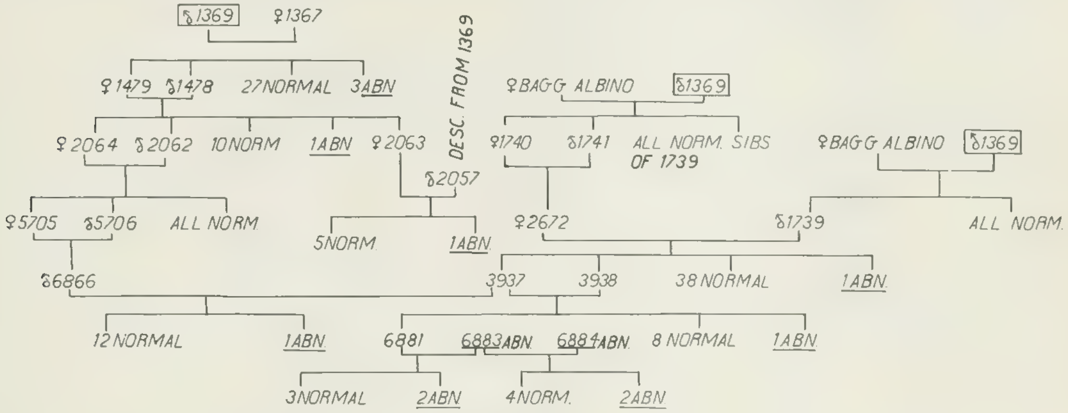


Chart I.

Chart II contains only animals that are descended from the outcross referred to. It will be seen that there are several abnormal-footed mice (15, to be exact) among them. Male 3492 is of interest, for by Females 5762 and 5763 he gave a total of 11 normal and 9 abnormal young. Both these females and Male 3492 himself were normal in appearance. The proportion of abnormal-footed young suggests however, that either he was genetically abnormal while the females were normals carrying abnormal foot as a recessive, or

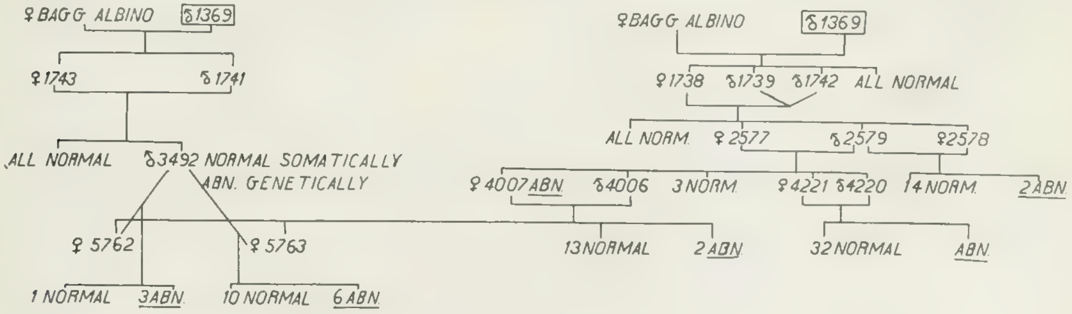


Chart II.

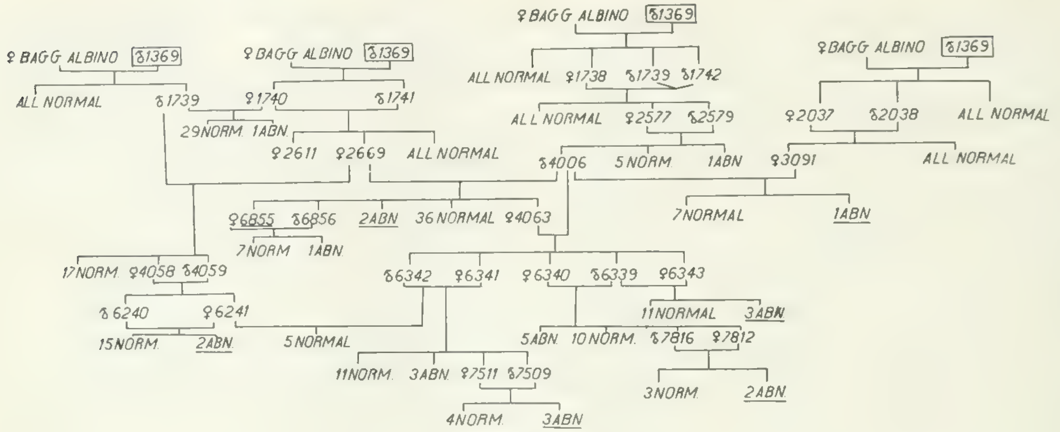


Chart III.

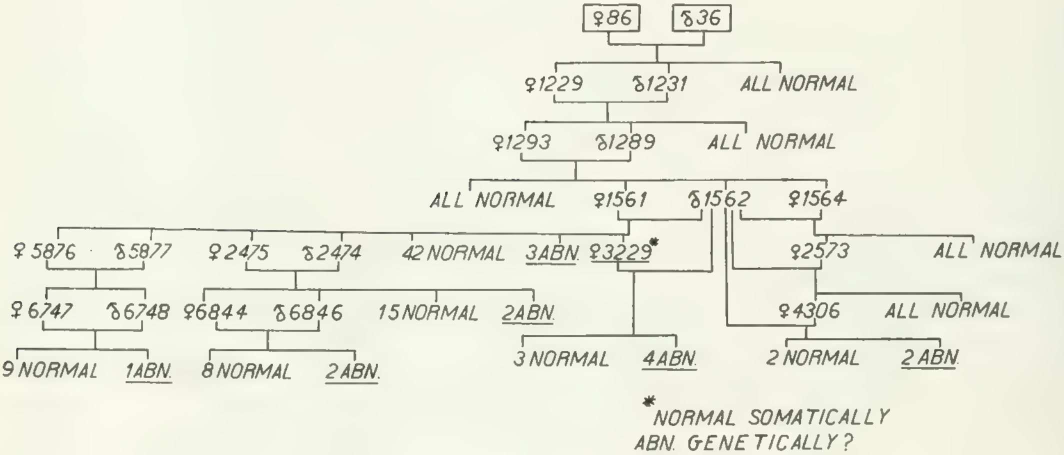


Chart IV.

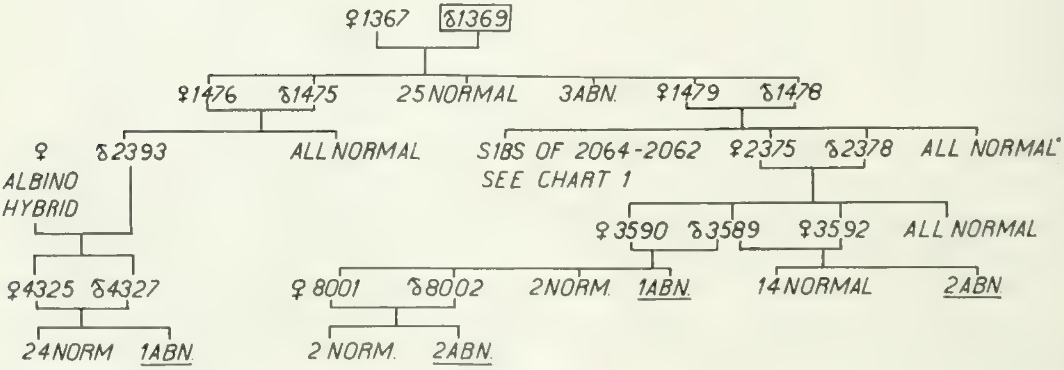


Chart V.

that both of the females were genetically abnormal although somatically normal and that he was a normal, carrying recessive abnormal foot. Of the two possibilities the former seems the more likely, for it requires that in one individual only, instead of two, would have to be present the usual condition of a "normal overlap."

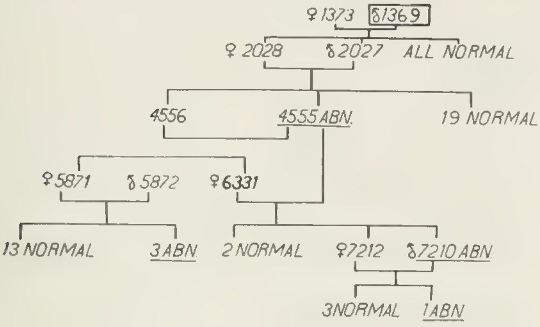


Chart VI.

These "overlaps" do not appear to be as frequent in the abnormal foot series as they are in the abnormal eye series.

Chart III shows extensively family descendants that are also from the original outcross. Although the numbers obtained from the cross of Female 7511 by Male 7509 are small, they suggest the possibility that one of these animals may have been a normal overlap and therefore genetically an abnormal.

On Chart IV is shown another entirely distinct family descended from a second pair of *x*-rayed mice, Female 86 and Male 36. The first abnormal-footed animals to appear were in the fourth generation. One of them, Female 3229, may possibly have been genetically abnormal although somatically normal, as her progeny consists of 3 normal and 4 abnormal young individuals, a close approximation to a 1:1 ratio.

Charts V and VI show two lines of matings giving abnormals, but confined to the original family in which No. 1369 himself appeared.

Female 1367 in Chart V was his sister and Female 1373 was his half-sister. Taken alone these two charts could not be used as proving inheritance, but in conjunction with the charts showing the outcross they indicate clearly that the abnormal-foot character was being inherited in this inbred stock and that Female 1367 carried the foot abnormality, while Female 1373 did not.

Chart VII shows what in some ways is a complicated line of descent from the outcross series: Female 6269 is one of the most likely cases on record of an animal somatically normal but genetically an abnormal. By two males, No. 6136 and No. 6237, she has given approximately equal numbers of normal and abnormal young. Although the numbers are small, the case seems to be fairly clear.

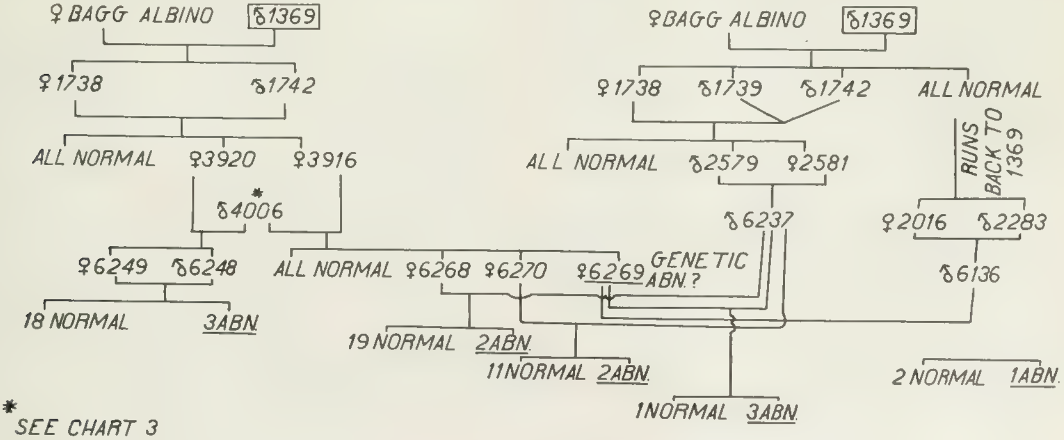


Chart VII.

Chart VIII brings us again to a series of matings all within the inbred line in which Nos. 1367, 1369 and 1373 originated. As proofs of the fact of inheritance, these pedigrees are inadequate and must be supplemented by as careful and extensive experimental work along the line of an outcross as it is possible to carry out with the material available.

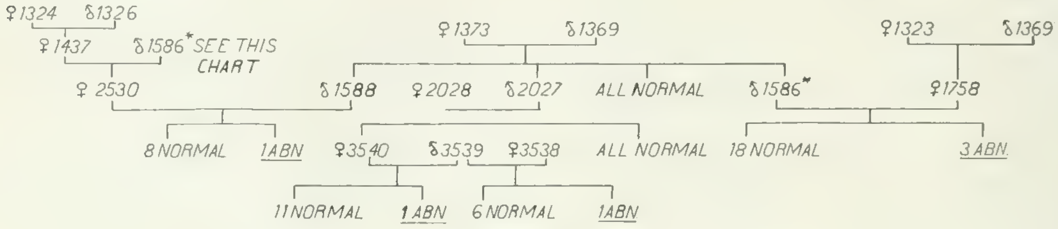


Chart VIII.

In one way, Chart IX presents evidence along the line of an outcross. The line used was one in which the ancestors had been *x*-rayed. The fact, however, that no young with abnormal feet have been born among the *inbred* descendants of Female 84 and Male 36 serves as evidence that the foot abnormalities have again been introduced by Male 1369, although it is not certain from which of his parents he and his sister Female 1367 derived them.

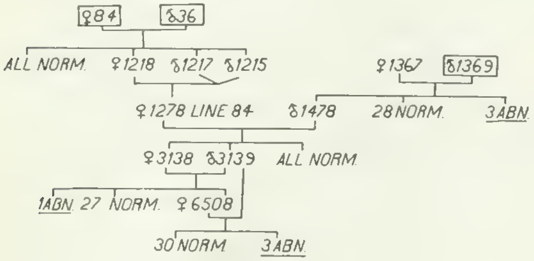


Chart IX.

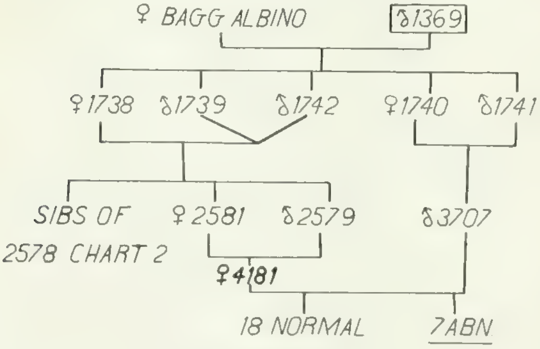


Chart X.

The reappearance in Chart IX of abnormals among the inbred descendants of Female 1278 and Male 1478 is an excellent supporting test of inheritance of the abnormal-foot condition.

Chart X is a small supplementary chart which might have been added to Chart II, but for the resulting confusion due to too many lines of descent. It presents no new features, being merely an excellent example of the action of the abnormality, which, after remaining unexpressed for four generations, suddenly appeared in the progeny of Female 4181 × Male 3707 in 7 animals.

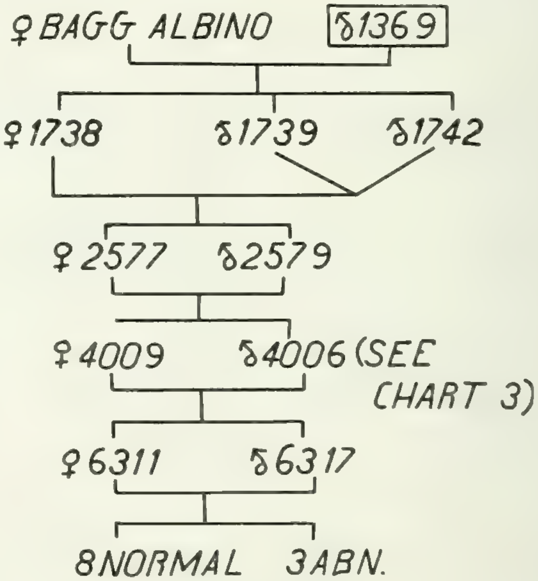


Chart XI.

Chart XI is another side line of the same general family. The pedigree in this case has been abbreviated and made diagrammatic in order to bring out the main point, namely, the appearance of the abnormality in the fifth generation, shown in the *seventh* after the *x*-ray treatment was actually given.

To sum up these charts, we may say that there are four main points brought out by them:

1. A true test of inheritance of the foot abnormality is repeatedly shown by the outcrosses between females of the Bagg albino race with Male 1369.
2. A secondary test of inheritance is shown in Chart IX where an outcross with animals of *x*-ray (line 84) is shown.
3. The occurrence of the potentiality for giving abnormal feet is shown by Chart V to be present as far back as the F_1 (first) generation *after* the *x*-ray treatment was given.
4. Certain animals by their breeding behavior (Male 3492, Chart II, Female 3229, Chart IV, Female 6269, Chart VII) indicate the fact that they are somatically normal but genetically similar to a mouse with abnormal feet. This occurrence of "normal over-laps" is the common experience of those who investigate the inheritance of structural characters in birds and mammals.

DISCUSSION

There are certain aspects of the experiment herein described which are worthy of careful consideration from a general medical and therapeutic viewpoint. Thus, if we are right in assuming that the eye abnormalities which we have been considering are the result of a change in the germ plasm induced by treatment of adult mice with *x*-rays, several conclusions follow.

The first of these is that although the somatic tissues of the treated mice themselves show no gross histological changes, there has been an effect on the germ plasm. This effect has resulted in a genetic change which is inherited. Its inheritance is orderly and mendelian. Its somatic manifestation is an abnormality of the optic nerves and eyes. This all suggests, of course, the need of extreme caution in the use of *x*-rays for medical purposes when the individual treated is of reproductive age or younger.

In the case of neoplasms, where the situation is serious, there seems naturally little reason why *x*-ray treatment should be curtailed. For purposes of temporary sterilization, the use of the *x*-ray appears to the writers to be a tremendous risk. While the treatment of the individual case might result most satisfactorily, the desired results being promptly and successfully obtained, the possibility of influencing the progeny by producing hereditary changes in the germ plasm cannot be ignored. Because of the long time interval between human generations, the immediate result, rather than the influencing of the germ plasm, has come to be our natural viewpoint. This viewpoint will, either directly or indirectly, be the worst enemy of an experimental test like the one here described. For this reason, if for no other, it is unfortunate that the medical men interested in the application of *x*-ray treatment to other than cancer cases, cannot see the experimental results themselves. The clear and striking abnormality must lose force in description.

It should be noted in passing that none of the work here reported indicates that *x*-ray photography as at present practiced in the medical and dental professions is harmful. Of course, the region photographed and the intensity and duration of the exposure will determine this factor to a large degree.

It would be highly desirable to conduct a series of experiments on the radiation of various portions of the body, and to study what genetic effects, if any, are produced. Since in our work the exposure was over the whole dorsal surface, there are no data that bear on this matter of localization. Fraenkel describes the treatment of the heads of guinea-pigs with *x*-rays, and the subsequent appearance of hairless areas on the head, not only in the treated animals, but in their progeny.

If confirmed with larger numbers and carefully controlled genetic stock, this finding is of prime importance, for here the effect on the germ plasm would necessarily have been secondary to the direct effect on the soma (head). This looks far more like inheritance of an acquired character, while our results appear to be in the nature of a *direct* effect.

The work of Mavor on Drosophila has also shown that the distribution of the chromosomes at maturation may be influenced by *x*-rays. The result of this is the production of non-disjunction of the sex chromosome. This condition appears to be inherited. The effect, however, may be primarily on the cytoplasm, and the result of a change occurring there may well be imagined to show itself in the distribution of whole chromosomes or other abnormalities of the mitotic process.

As before mentioned, the experiments of Blakeslee and Gager are also probably explicable along this same general line of reasoning.

The orderly behavior of the eye abnormality here recorded suggests, however, that in this case a single gene, or a small area of the chromosome, has been affected. There is, as we have stated, no evidence of the inheritance of an "acquired" character to be derived from this experiment with mice. It appears to be a direct effect on the germ plasm itself.

It is interesting to note in passing that Guyer and Smith, in their experiments on the production of lens antibodies in rabbits, are inclined at least to consider that the inheritance of an acquired character is involved. Without wishing to detract from the great merit of their work, it should, it seems, be pointed out that the pedigrees which they have published in their papers in the *Journal of Experimental Zoölogy* show undoubted *transmission* of some sort of tendency to defect, but so far as we can see, they contain no actual test of true inheritance of the type referred to above under the headings of both eye and foot abnormalities. In every case that we have noticed, Guyer's pedigrees show either a chance for transmission by the female, or else a cross with an actually abnormal male individual. Here, of course, a great amount of actual material besides the sperm itself is introduced from the abnormal male into the body of the female and affords at least a possibility of direct transmission of some agent causing the abnormality.

In closing, therefore, we should like to review briefly what we believe to be the important points in the results here reported:

1. Abnormalities of the eyes and feet have first appeared among the second and third generation descendants of mice which as adults had been given one-fifth of a human erythemal dose of *x*-rays on each of five successive days.
2. The first young were obtained from treated animals as late as ten weeks after their treatment, thus insuring no in utero effects.
3. The eye abnormality is inherited as a mendelian recessive character.
4. The foot abnormality is also inherited, but as yet the exact nature of its inheritance has not been worked out.
5. The fact of the appearance of these abnormalities, the clear lesions involved in their somatic expression, their absence from the control animals, and the work of others who have used the physical agents lead us to believe that the *x*-ray treatment has had a causative effect upon their production.
6. This effect appears to be of the nature of a direct effect on the germ cells themselves, not *through* the soma as an acquired character.
7. The experiments here recorded justify, we believe, the recommendation of extreme caution in the use of radium or *x*-ray therapy on human individuals who are likely ever to serve as parents after they have been treated.
8. This caution should be practiced until the whole matter of the effect of *x*-rays and radium on the germ plasm has been much further investigated than at present.

BIBLIOGRAPHY

Bagg, H. J. Disturbances in mammalian development produced by radium emanation. *Am. J. Anat.*, 1922, xxx, 1.

Castle, W. E. The origin of a polydactylous race of guinea pigs. *Carnegie Inst. Wash.*, Pub. 23, 1906.

Davenport, C. B. Inheritance in poultry. *Carnegie Inst. Wash.* Pub. 52, 1906.

Doncaster, L. Notes on the inheritance of colour and other characters in pigeons. *J. Genetics*, 1912, ii, No. 2.

Fraenkel, M. Investigations with roentgen rays on animal ovaries as a demonstration of the inheritance of acquired characteristics, and their bearing on the cancer problem. *Strahlentherapie*, 1921, xii, No. 1.

Hertwig, G. Parthenogenesis bei Wirbeltieren, hervorgerufan durch artfremden radiumbestrahlten Samen. *Arch. f. mikr. Anat.*, 1913, lxxxi, Abt. II.

Das Schicksal des mit Radiumbestrahlten spermachromatins im seeigelei. *Arch. f. mikr. Anat.*, 1912, lxxix, Abt. II.

Hertwig, O. Die Radiumstrahlung in ihrer Wirkung auf die Entwicklung tierischer Eier. Sitzgsber. Akad. Berlin, 1910. Die Radiumkrankheit tierischer Keimzellen. *Arch. f. mikr. Anat.*, Abt. f. Zeugunslehre, 1911, 77.

Hertwig, P. Durch Radiumbestrahlung hervorgerufene Veränderungen in der Kernteilungsfiguren der Eier von Ascaris megalocephala. *Arch. f. mikr. Anat.*, 1911, lxxvii.

Mavor, J. W. An effect of *x*-rays on crossing over in drosophila. *Proc. Soc. Exper. Biol. & Med.*, 1923, xx, 335.

Staples-Browne, R. On the inheritance of colour in domestic pigeons, with special reference to reversion. *Proc. gen. meet. Zool. Soc. Lond.*, 1908, p. 68.

Wright, S. Studies of inheritance in guinea-pigs and rats. *Carnegie Inst. Wash.* 1916, p. 192.

FORCEPS FOR CLEANING RADIUM NEEDLES AND TUBES

BY J. S. ULLMAN, M.D.

NATCHEZ, MISSISSIPPI

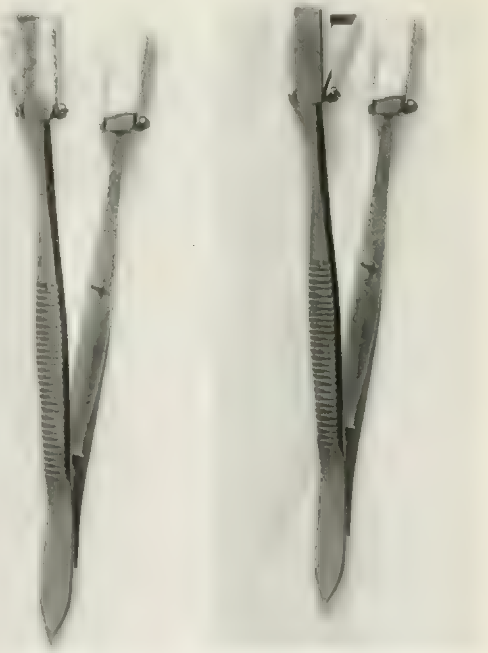
THIS instrument was devised as an additional means of protection for the therapist and technician. It has always been apparent to workers with radium that a very appreciable danger lies in drawing the container between the fingers when they are covered with nothing but a few layers of cloth.

It will be seen that this apparatus will add considerably to the convenience and efficiency of the technician, for to try to hold a needle on the table with ordinary forceps while mopping with another pair of forceps is a most cumbersome procedure at best.

It will be seen that the instrument is an adaptation of the embroidery hoop and consists of a pair of ordinary anatomical forceps on the ends of which have been fixed rectangular plates, the edges of these plates being turned back to give rigidity. Bands of very light spring metal are fitted around the turned-back edges and fastened by through and through pins to the proximal ends of the plates in such fashion that the pins may be lifted up for the insertion of gauze or other cleansing fabric. Obviously the bands are returned to the proper position along the edges of the plates and finally hold the material to be used for wiping or polishing a tube or needle.

Ordinary surgical gauze may be used for drying the radium containers. By adding oil and emery flour to the surface of the gauze, or by using some abrasive cloth, the instrument becomes a most efficient means for polishing the container.

Anyone who has tried to clean dental compound from containers knows that considerable effort is required to remove this material. A fine abrasive applied in this manner, however, does this work better than anything else known to the writer.



It will be seen from the illustration that this instrument is simple in its construction and use. So far as is known to the writer it is the only thing of the kind to protect the therapist and technician.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. Imboden, M.D.
Associate Editors: James T. Case, M.D. H. K. Pancoast, M.D. William Duane, Ph.D.
Publisher: Paul B. Hoeber, New York

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

FIFTH ANNUAL MEETING EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY
CHALFONTE-HADDON HALL, ATLANTIC CITY, N. J., JANUARY 24–26, 1924

THE CHICAGO MEETING

Among the twenty-four annual meetings of the American Roentgen Ray Society the last meeting at Chicago stands out as one of the most interesting. This interest was developed along several lines, but perhaps was most apparent in connection with the papers pertaining to therapy. This was indicated by the large number of guests and members taking part in the discussions. The address by Dr. Robert Knox of London, England, was one of the outstanding features of the meeting. The attendance of both members and guests was the largest recorded in recent years. Besides Dr. Knox there were several other foreign guests, among whom were:

Dr. Arthur Burrows, Manchester, England.

Dr. Alfred G. Dominguez, Havana, Cuba.

Dr. J. Stanley Ellis, Shantung, China.

Dr. Carlos Johnson, Havana, Cuba.

Dr. Jose Ochotorena, Havana, Cuba.

Dr. Filiberto Rivero, Havana, Cuba.

Dr. Carlos Heuser, Buenos Aires, S. A.

Dr. Paul Hodges, Peking, China.

The scientific and commercial exhibits were large, and much that was new and interesting was shown.

The officers elected for the ensuing year were:

President-Elect: Dr. George W. Holmes, Boston, Mass.

First Vice-President: Dr. Frederick M. Law, New York, N. Y.

Second Vice-President: Dr. Ernest C. Samuel, New Orleans, La.

Secretary: Dr. W. Warner Watkins, Phoenix, Ariz.

Treasurer: Dr. William A. Evans, Detroit, Mich.

Librarian: H. W. Dachtler, Toledo, O.

Member of Executive Council: Dr. Harry M. Imboden, New York, N. Y.

With this number of the Journal the present editor terminates his official relations with it. While the various tasks of the office have at times seemed exceedingly difficult, even unsurmountable, they have not been without proper and due compensation in the form of unusually close relationships which were developed not only with the various members of the Society but with foreign correspondents and other editors. The emotions which one experiences upon such an occasion are of mingled regret and relief; regret in laying down work which has become part of one's routine, and in the severing of some of the choicest relationships; relief that the time which was devoted to the Journal may now be devoted to other fields, and also in the thought that the Society has entrusted the future of the Journal to hands which have been tried in various fields and never found wanting. It is to be hoped that the members will accord to the new editor even a greater degree of cooperation and support than was given the present one. If this is done, his lot, indeed, will be cast in pleasant places and the future of the Journal will be assured. Gratitude for invaluable assistance is extended to the associate editors, Dr. William Duane, Dr. Henry K. Pancoast and Dr. James T. Case.

CORRESPONDENCE

To the Editor:

I have completed my work in connection with the raising of the memorial fund for Dr. Van Zwaluwenburg. The total subscriptions received amount to $2972.50. The money was invested from time to time, and the total earnings amount to $153.46. I am turning over today to the treasurer of the University of Michigan for permanent investment this total, $3125.96.

Very sincerely yours,
Wm. A. Evans.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal (69 *East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

Principles of X-ray and Radium Dosage. By Albert Bachem, Ph.D. Cloth, Price, $8. Pp. 274, with 67 figures. Chicago: Albert Bachem, 1923.

X-ray and radium therapy have had careers of ups and downs similar in many respects to other therapeutic measures, but it seems at the present time that they are both in the process of settling. This is due to the fact that the biological factors of radiation have been extensively studied and are fairly well known while the limitations of the applications of deep x-ray therapy and radium may be considered as not yet conclusive. This book, therefore, comes at a very fortunate time, as it contains the underlying principles of radiation, discussing such important problems as the determination and measurement of quantity by radiation, the definition and measurement of quality, the distribution of various kinds of rays in different media and a very important chapter on practical dosage. The author draws largely on literature which has been very voluminous in the past five years and tempers his conclusion with his own experiences. This book merits the serious consideration of all interested in deep roentgen and radium therapy.

First Aid X-ray Atlas of the Arteries. By H. C. Orrin. Cloth, Price, $1.00. Pp. 46, with 9 illustrations. New York: Paul B. Hoeber, Inc., 1923.

This small atlas is intended to give a conception of the arteries of the body, especially in their relationship to the bones. The plates, while small, are very satisfactory and should be of service to first-aid students as well as to nurses.

Physiotherapy Technic. A Manual of Applied Physics. By C. M. Sampson, M.D. Cloth. Price, $6.50. Pp. 443, with 85 illustrations. St. Louis: C. V. Mosby Co., 1923.

Of all opportunities given to men to investigate somewhat unknown fields, those taken advantage of by Dr. Sampson have amounted to such a volume that his observations of the necessities of technique are really most important. This book gives particularly good descriptions of the real technique in physiotherapy. This first edition, however, is really "padded" with unnecessary parts, for doctors do not need to be told how to examine patients. The many anecdotes and personal examples in the book are interesting but unnecessary; also his various disagreements with other Army doctors. Aside from these extraneous thoughts, the real "meat" of his book is good. This applies especially to his explanation of high-frequency electricity and the technique and applications used in diathermy.

The chapter on Indirect Diathermia or the Use of the Non-vacuum Electrode is to be commended because it omits any consideration of the vacuum electrode now popularized as the "violet ray." This "violet ray" is one of the greatest detriments to electrotherapy that has ever been foisted on the public.

The chapter on Static Modalities brings forth many truths of static electricity which have never been sufficiently emphasized.

Actinotherapy and phototherapy are both very well presented, and though it is evident that Dr. Sampson was quite successful in the treatment of x-ray burns, he lays almost too much stress on this work.

The use of galvanic, faradic and sinusoidal currents is well explained and brought forth.

Massage and hydrotherapy are given a good modern exposition and the new form of hydrotherapy, namely the whirlpool baths, is explained.

The most necessary chapter is called Trouble Shooting and should certainly be included in any book on technique, though Dr. Sampson is the first to think of such a separate chapter.

On the whole, this book is worth while in the strictly scientific and technical parts, and it is a step in the right direction to show that scientific application of physiotherapy is an aid to established medical and surgical treatment of disease.

N. E. T.

TRANSLATIONS & ABSTRACTS

Conclusion of Abstract of Proceedings of Meeting held at Heidelberg, May 26–27, 1923.

Döderlein (Munich). The therapy of gynecological cancer with radioactive substances. Whether the radioactive substances radium and mesothorium are in their effect identical with each other and with the roentgen rays, has not been definitely established. They have the advantage over roentgen rays of emitting rays harder than can be produced by any roentgen apparatus so far designed. Their disadvantage is that their application is quite limited locally. On the other hand, their application requires less of the operator's time, and aside from their great initial expense, they are cheaper to use. Since the life of radium is reckoned as eighteen hundred years, while that of mesothorium is only twenty years, it is not established that mesothorium does not, on account of its more rapid decomposition, have an effect different from that of radium.

With these substances there have been treated in the Munich University Frauenklinik in the years 1912–1918, 1016 cancerous women. These cases included 962 carcinomata of the female genitals.

Predominant among these was cervical carcinoma, with 755 cases. It is now more than five years since the treatment of these patients was finished, so that Winter's statistical requirement has been satisfied. Of these 755 patients, 103, or 13.2 per cent, are living and apparently cured.

When one considers that the results of the radical abdominal or vaginal extirpation of the carcinomatous uterus show, for all operations, an absolute percentage of cures of 20 to 25, one might estimate the curative power of radiation treatment as only about half that of surgical. This, however, would be a fallacy, and would hinder scientific progress; for it is to be considered that radiation treatment is used upon much more unfavorable material than is surgical, which naturally holds down the percentage of cures. This is confirmed by a comparison of the percentage of operability in the material in question with that previously seen. While the author used to operate on from 60 to 70 per cent of the carcinomata of the uterus which came to him, this material, 755 patients, included only 110 operable cases, at operability percentage of 14.58.

Of these 110 cases, designated as Group I, 48 have been cured by treatment with radioactive substances, that is, on recent follow-up more than five years after the end of treatment, there were found alive and well 43.6 per cent.

In Group II, comprising the so-called "borderline cases," in which the possibility of surgical extirpation could be entertained, there were 136 patients, of whom 31, or 22 per cent, have been cured.

In Group III were 340 patients too far gone for any possibility of radical extirpation. Of these, 23, or 6.7 per cent, have been cured; and of the 169 patients in Group IV, hopeless cases, one has been cured.

The author believes that in estimating the value of cancer treatment in the future, the quality as well as the quantity of the material will have to be considered.

These figures represent the minimum value of radiant therapy, for in the first years of the method to which they correspond, the technique was being developed and the correct dosage had to be learned. A lamentable feature of radiation treatment is that the patients have to be seen a number of times, and not seldom the improvement is so prompt that they do not return for the full course. Such insufficient treatment naturally depresses the showing for the method, without constituting any evidence as to its lack of value, just as in syphilis one can designate salvarsan as a useless drug because there are cases in which its incorrect use has led to no result. If one excludes from the foregoing statistics those cases in which the treatment was incomplete, in which there were not at least three sittings, we have the following showing:

Group I 62 cases, 46 cured, or 73.6 per cent;
Group II 75 cases, 31 cured, or 41.2 per cent;
Group III 176 cases, 23 cured, or 13.1 per cent.

These figures may be regarded as showing the maximum result for the present-day treatment of carcinoma of the cervix with radioactive substances.

In the same period the author has treated 47 cases of carcinoma of the body of the uterus, with 11 cures. Of these 47 cases, 24 were operable, and only in these was a cure obtained; the 23 inoperable cases were all lost. In connection with the discovery, made in collaboration with the pathologic department, that the adenocarcinoma is resistant to radiation, the unfavorable results with the carcinoma of the body of the uterus appear to be explained by the lack of sensitivity of the gland-carcinoma. It is likely that this will alter our attitude in the treatment of carcinoma of the body.

Of recidiv following operation elsewhere, the author saw in the period in question 57 cases. Not one of these patients was living after five years. According to the joint experience of the surgical, dermatologic and pathologic departments, which have observed rapid extension of the carcinoma after diagnostic excision, this lamentable characteristic of recidiv appears in a new light: in all local recidiv cases, the operation is only a great diagnostic excision, and if even a small incision into the carcinoma will make the cells run wild, it is plain that biologic alteration of the carcinoma cells in consequence of operative interference will render these cells resistant to radiation. The author warned against this years ago, and believes that in view of the results of radiation alone, we should in the future withhold surgery where the carcinoma is accessible to radiation.

The remaining results with the author's material are as follows:

Of 65 cases of vaginal carcinoma, none has been cured by radiation. It appears, that in these cases the growth extends so rapidly into the surrounding tissues that the radiation therapy, like the operative, has as yet been unable to produce any result.

Likewise, poor results were obtained in 14 cases of carcinoma of the ovary. They were all operated upon, since it is naturally out of the question to handle such large tumors by radiation alone. Only one case has been cured.

Of 17 cases of carcinoma of the vulva, only one case has been cured, of 7 carcinomata of the urethra, none. Here the radiation treatment fails as well as the operative.

These results make it all the more worth while to try to sensitize the carcinoma in various ways, perhaps even through radiation of the hypophysis.

In confirmation of the conception that radiation has a selective effect, the author points not only to the anatomical investigations upon the alterations in the carcinoma cells following radiation, but especially to a case which he has already described (*München. med. Wchnschr.*, 1922, No. 7). This deals with a woman thirty-one years old who in 1913 developed a rapidly growing carcinoma of the portio, which was so favorably influenced by radiation that on April 12, 1919, she gave birth to a fully developed living child. In this case the diseased organ was so completely restored to normal that not only its anatomic structure but its biologic function was not entirely free from damage.

Wintz (Erlangen). Experience with roentgen therapy of cancer in the erlanger frauenklinik. The action of radium is limited to a depth of 3 to 4 cm. Radium is indeed biologically potent, but amounts sufficient to compare in effect with *x*-rays are not to be had. Seitz and Wintz formerly combined radium and roentgen rays, but in the last three years Wintz has treated portio-carcinoma with roentgen rays alone, and recently has used (ionic) copper as an adjuvant. Only in cases in which an adequate dose was given was there regression; at least 90, often 110 per cent of the single skin dose has been necessary. But while we here have a fundamental principle for the destruction of the carcinoma, we still have not the key to the healing process; this is a biologic moment which we have not yet mastered, though we have extensive destruction-methods at our command. Destruction and restitutio ad integrum, however, are not one and the same thing.

As for technique, Wintz uses one vulva field, two abdominal fields, one anal field, and two dorsal fields. Then the parametrium is radiated. In twelve weeks if the tumor has not vanished, there has been a fault in the technique. But the disappearance of the tumor does not mean a cure. The dosage remains the deciding factor.

With the aid of ionic copper, results are attained which surpass those of roentgen rays alone. The copper salts are driven into the tumor mass by cataphoresis, as well in the parametrium as in the portio. Appropriate disposition of the cathode and anode deposits much copper in the tumor, little in the skin. Among the unfavorable effects, vascular injuries are frequent. Double the erythema dose leads to induration of the skin, which resolves in from one to two years and which must not be interfered with, except perhaps for the application of heat. Furthermore, a damage of the vault of the bladder is often observed, and the bladder must therefore be empty at the time of treatment. Also, a tendency to calculus formation in the bladder is seen.

Every place that has had half a roentgen dose (skin, intestine, etc.) is to be regarded as a locus minoris; here a slight trauma suffices to cause damage, e.g., the pressure of a corset, etc. Diagnostic excision is the worst of all, and the author warns against it.

In carcinoma of the breast he uses large fields at a distance, 120 to 150 cm. skin-focus distance, through 3 mm. of aluminum. Deep radiation damages the lungs and causes induration of the pleura.

Statistics. Carcinoma of the portio: 15 per cent free after four years. Carcinoma of the breast: 4 out of 17 cases free five years; 7 out of 12 free four years; 19 out of 47 cases free three years.

Sachs (Heidelberg). The New Methods of Serodiagnosis of Cancer. The experimental attempts of the last ten years to immunize animals against cancer material by the use of cancer serum have failed. This has limited the hope of a serodiagnosis of cancer. Abderhalden's theory of the excavation of organs by cancer by means of ferments has not been confirmed by Sachs and Oettlingen. Kottmann (Bern) has a method different from Abderhalden's, but he, too, has failed to obtain clear, practical and useful results. The fixation of complement in tumor diagnosis deserves looking into. The serum of patients who have tumors frequently gives a falsely positive reaction for lues. Lability of the blood proteins in pregnancy, infectious diseases and tumors gives rise to chemical methods of investigation. The determination of the antitrypsin content gives unreliable results.

Alterations in the serum of tumor patients can nevertheless be found in the overwhelming majority of cases. The similarity of the sera of pregnant women, patients with infectious disease, and with tumors, is significant: the cause is excessive tissue growth and tissue destruction. More to our purpose would be a reaction which would occur in only 30 per cent of cases, if it would occur only in the presence of a tumor.

There is thus no characteristic serodiagnosis for tumors; there are symptomatic reactions, which serve as aids. The question whether it is possible ever to discover a serodiagnosis of cancer is still an open one.

Kahn (Altona): A simple flocculation reaction associated with malignant tumors. During investigations upon the applicability of the varying inhibiting power of various sera toward hemolysis with sodium oleate for the differential diagnosis of malignant tumors, it was found that especially in tumor patients the decrease of the power to inhibit sodium oleate hemolysis parallels a degree of cloudiness which appears some time after the serum and oleate are brought together. Technique: Six test tubes, in each of which are 0.2 c.c. of serum, then 0.2 c.c. of glycerin, and in increments of 0.05 c.c., 0.2 to 0.4 c.c. of sodium oleate solution. Cloudiness or flocculation is then read off. The reaction was positive in all cases examined of carcinoma of the gastrointestinal tract, the liver and the pancreas; with the exception of a case of carcinoma of the pancreas with severe cholemia. It was otherwise positive only in cases of highly febrile tuberculosis, in several cases of highly febrile acute infections, and in extensive cirrhosis of the liver. These do not influence the practical application of the reaction, for these conditions may be distinguished clinically. It cannot be theoretically regarded that this has to do with specific immunity reaction.

The advantage of the reaction over the old hemolysis methods and the meiostagmin reaction is that while the exactness is about the same, the manipulation is considerably simpler.

A positive reaction consists in the appearance of flocculation after the addition of 0.25 c.c., of cloudiness after 0.3 c.c. of the neutralized 0.1 per cent oleic acid solution.

Caspary (Frankfurt-on-Main): Cancer and immunity.

The methods of producing unspecific immunity are manifold. It can be induced by parenteral injection of foreign proteins, tissue autolysates, blood transfusion, implantation of embryonal tissue, chemicals, protoplasmic poisons, and especially by complex metal salts. Coincident with cell destruction there appear effects from small doses of roentgen rays; likewise from fevers. Even dyspnea sets immunity processes in motion. The percentage of fatal cases in men who do bodily labor is smaller than in those who do not. The catabolism of cells increases the resistance. According to the necrohormone theory, the stimulation of the necrohormone causes growth of connective tissue: hence the defensive process of the body. First the lymphocytes appear at the disease-focus, and are there transformed into fibroblasts. The process is identical with scar-formation. The best effect for immunization is obtained by the introduction of any kind of tissue. The first degree of the effect is a lengthening of the latent period and better tolerance of the tumor. The second degree is marked by a definite hindering of the growth.

So far there is no prospect of these consequences of therapy being available in man. Diathermy produces a local increase in temperature and can thus be of use. The production of fever leads to weakness. Injection of metal salts has only an adjuvant effect. Roentgenotherapy. Little is to be expected from passive immunization. Experiments upon immunity processes can yield us practical means for therapy.

Werner (Heidelberg). The new biologic and chemotherapeutic methods of treating cancer.

Despite operation and radiation, more than 85 per cent of cancer patients die. The biologic and chemotherapeutic procedures are regarded as either strengthening of the radiation effect or delaying postoperative recidiv or else as independent measures. The object is always an influencing of the blood or lymphatic channels or the tumor cells themselves in the sense of a destruction or of a resistance of the region of the endocrine organs.

It is seldom that there is an attempt to utilize the chemical affinity of tumor cells for an injected substance. There is, however, often an indirect effect, by reducing the blood supply or by the stimulation of endocrine organs. Chemical therapy in the strict sense comprises the use of clinically tested preparations of arsenic, iodine, silicon, silver, copper, iron, selenium, vanadium, and lead; and further, the use of vital stains.

For chronic use, arsenic is employed in small or medium-sized doses; upon the application of large doses, many lymphosarcomata heal, likewise myelogenous bone tumors, and skin cancers. Intravenous injection of large doses of atoxyl, salvarsan, or related preparations is followed by rapid melting away of even large sarcomata, but at the price of a stormy general reaction that is not free from danger.

Intratumoral injection of potassium iodide for the purpose of making more effective the radiation is disappointing.

Silicon occupies a place not only in folk medicine, but also in the form of various combinations for use by mouth or by injection as true or colloidal solutions. Isolated examples of its successful use in confirmed carcinoma have been described, but the single trial of the author was negative.

Silver and copper salts are given either intravenously or intratumorally, in the hope of destroying the tumor cells or of strengthening the effect of radiation, or for the indirect effect through the blood. The preparations most frequently used are collargol, argatoxyl, fulmargin and argoflavin; and of the silver salts, cuprase of the copper. Again, only isolated results are attained, at the price of severe constitutional reactions. Wintz has used copper intratumorally and believes that it increases the radiation effect.

Selenium operates, in the combinations so far tried, as does arsenic, but the dosage is difficult, and large doses produce mild intoxications; moreover, the tolerance of difference individuals appears to be very different. The form best withstood the colloidal selenium-vanadium. Some carcinomata of the gastro-intestinal tract have shown apparently good results.

Iron is used principally for the betterment of the blood-picture. In secondary anemia and beginning cachexia an especially favorable effect is seen. It is particularly important to give this aid for the constitution before radiation.

The acetate of lead, which has been recently recommended on all sides was tried by the author fifteen years ago, and has not proved of value.

Vital stains, especially methylene blue and methyl violet, stain the tumor intensely, but have little application in combination with radiation. Roosen has devised an interesting method of giving subcutaneously methylene blue, which stains the tumor and the body tissues; the body tissues soon become decolorized, but the tumor does not; the administration of calomel is then expected to produce bichloride of mercury in the tumor. Or, isamin blue is injected until it stains the tumor deeply, and then neosalvarsan is injected to produce toxic oxidation products in the tumor. Unfortunately these two methods have not produced convincing results.

Injection of cholin compounds sensitizes the tumor to radiation, but it also sensitizes the skin, so that as yet no advantage has been derived from it.

The injection of protein bodies, e.g., casein compounds, has a definite effect for the better on the general state of the patient, but little effect on the tumor itself. The effect of bodies given to increase the lymphocytes, e.g., sodium nucleinate, is not much different.

On the other hand, one sees that, with the intravenous injection of foregoing or even any kind of sera, organ extracts, expressed tissue juices, and autolysites of tumors, either similar to or different from the tumor treated, have a good effect on the tumor, especially at the beginning of treatment, and sometimes there is a considerable diminution of the size of the tumor. As a rule the failure of the treatment is observed in four to five weeks. One can hope, however, for a new therapeutic weapon with the development of the method. How far one can hope for results by combinations of these procedures, and especially by increasing the doses, is still quite uncertain.

In the sense of protein-therapy, such remedies as the antimeristem of Schmidt, or cirrhosan, give some effect, but the experiences so far have yielded but little.

In some cases there have been seen apparent healing of hopelessly sick patients, giving the impression of a therapia sterilisans magna. As an example, a single intravenous injection of sterile filtered milk has been followed by the complete disappearance of an histologically demonstrated large carcinoma of the stomach.

We cannot count on these results unqualifiedly, because special circumstances of unknown kinds, beyond our control, e.g., the accidental admixture of bacterial products and the like, make it impossible to reproduce the conditions of a given case.

Erdmann (Berlin). Cultivation of tumor cells.

Epithelial cells can be cultivated in vitro without limit, if they are transplanted every second day. The medium must be semi-solid; if it becomes fluid it must be replaced at once. The cancer cells must be transplanted every twenty-four hours or oftener. This is why the cultivation of cancer cells is difficult. Normal cells from birds and mammals which grow without limit in vitro, die promptly when transplanted to a new host, in contrast to the inoculated tumors. Experiments are under way to reduce the resistance of the prospective host. An inoculated tumor continues only when stroma is inoculated with it. This calls renewed attention to the study of the stroma. But if too much connective tissue is present, the epithelial cells do not grow. The growth of epithelium is thus something secondary; it is linked up with the connective tissue stroma in some way.

Ellinger, Gans and Rapp (Heidelberg). Thorium nitrate as a means of sensitizing.

Starting from the standpoint that only the absorbed portion of the rays is effective, it was sought to permeate the tumor tissue with a substance of high atomic weight in the finest possible state of division. The substance had to be non-toxic. Thorium nitrate in 10 per cent solution together with 12 per cent of cocaine was injected into the tumor or the lupus tissue, and radiation applied. The injection is very painful, the pain lasting from half an hour to twelve hours. Injection of large tumors requires narcosis. Contrary to the usual roentgen handling, one begins with smaller doses, and should not exceed a third of the single skin dose. The increase of the effects is to be explained by the effect of the secondary electrons in the tissue. The method is danger-free with small amounts of the ray; with larger amounts there is rapid destruction. No fatalities.

Gynecologic Congress in Heidelberg. Section of Radiation Therapeutics, May 25, 1923.

Risse (Freiburg). Blood changes after radiation.

The author found in cases of carcinoma an acceleration of the decrease of the blood cells, but after radiation, usually a slower decrease, which lasted for six to eight weeks. Similarly, an increase in the cholesterin and lecithin content of the blood. In the majority of cases, after an initial hyperglycemia, there was a decrease of blood sugar. The values sank to as low as one tenth. In radiated diabetics the sugar in the urine decreased, but the sugar content of the blood remained unchanged. This was true of radium radiation as well as *x*-ray. The coagulation time was much accelerated in most cases by medium and large doses. The leucocytes decreased.

Mikulicz-Radeki (Leipzig). Roentgen radiation and the rate of decrease of the blood-cells. The author found acceleration after operation, and subsequent to radiation a slowing, later an acceleration of the fall of the blood-cell count. His experience agreed with Risse's. He hopes to obtain prognostic information. The cause of the slowing is alteration of the fibrinogen or electric charging of the red cells.

Martius (Bonn). Experimental investigations upon radiation effect.

In general, one accepts the theory that the difference between the sensitivity of the carcinoma cells and that of the surrounding tissue is greater for hard rays than for soft. In experiments with the radiation of bean and pea seedlings Martius found more damage by the soft rays than by the hard, but caution should be observed in applying such results to man. At all events, it does not appear that an increase in the hardness of the ray is necessary in deep therapy. The hardness must be great enough so that absorption occurs at the desired depth.

Hofbauer (Dresden). Clinical observations on radiation of the hypophysis. Investigations on the effect of radiation of the midbrain and the hypophysis upon the female genital tract.

After radiation of the hypophysis in normal women, the uterus showed swelling. The question whether a functional stimulation of the uterus can be attained by radiation of the hypophysis was thus answered in the affirmative. Pains were elicited like those following injection of pituitary substance. Hypophyseal radiation in functional bleeding, for activating metabolism, is to be studied. In one case a loss of weight of 18 kg. was noted in fourteen days. After radiation of the hypophysis only, the following changes in carcinoma were demonstrated histologically: vacuolization of the protoplasm, cessation of mitosis, and the appearance of fibroblasts. The carcinoma was definitely "radium-ripe" (material from the Munich clinic). Even the most conservative interpretation finds that in the cases in which the hypophyseal radiation was of good effect, the tumor cells underwent a decrease of vitality, the connective tissue cells showed an inflammatory reaction and the resistance of the organism was increased. Roentgen or radium therapy was then used. In some cases there were frank failures.

Werner (Vienna). Experiences with radiation of the spleen in gynecology.

Werner has radiated the spleen in 74 cases of bleeding and had results in 70 per cent. The best results were in young girls and with inflammatory tumors of the adnexa. In the greater number of cases permanent effect was not attained. Direct influence of the substance governing coagulation was suggested. In placenta previa, no prophylactic effect was attained. Three cases of melena neonatorum were cured.

Vorländer (Freiburg). Histologic observations on radiated mice with and without carcinoma.

The author demonstrated, by the use of 900 white mice, the effect of radiation of carcinoma.

The end stage is the formation of a connective tissue capsule and fat tissue. The connective-tissue cellular reaction is what brings about the obliteration of all the carcinoma cells. Proliferation processes in the connective tissue are an expression of a general reaction.

Kok (Heidelberg). Experimental contribution to the radiation treatment of carcinoma.

After radiation of mouse carcinoma with 200 kv. through 0.5 mm. of copper Kok saw constant regression; never a stimulation of the tumors. Medium doses had better effect than large; the epilation dose is perhaps the best. Large fields were better than small. The same effect was produced when the opposite half of the mouse from the one containing the carcinoma was radiated. From these observations it follows that radiation therapy must be placed upon a different footing, and that colossal doses do harm.

Döderlein, Jr. (Munich). Critical investigation of the carcinoma question.

An agreement between histologic structure and clinical findings can be demonstrated, to the extent that no cured cases of adenocarcinoma were found. The healed cases were pure solid carcinomata, presumably derived from the superficial epithelium. "Atypical epithelial growths" are hardly to be differentiated histologically from true tumors.

Weibel (Vienna). The relation between pregnancy and uterine carcinoma. A special malignancy of carcinoma of the uterus in the gravid cannot be claimed. The author cites fifteen cases, all operable. In thirteen, the gravidity was evidently older than the carcinoma.

As to the relation between age and uterine carcinoma, old people showed no more recidives than the younger.

Discussion: Döderlein regards the problem of the hypophysis as interesting and worth consideration. The midbrain appears to dominate the endocrine system.

Geller (Breslau) in 1921 radiated 3 cases of dystrophia adiposogenitalis and gave 60 per cent of the single skin dose over the hypophysis; in two cases, no result. In acromegaly and with very weak menstruation he gave the full dose with improvement.

Hirsch (Altona) believes that by stimulation of the hypophysis the whole organism is made more fit. This can also be accomplished by the injection of endocrine preparations. He dissents from a direct influence of the radiation of the hypophysis on uterine carcinoma. The hypophysis presides over the ovary; when it is impaired, the ovary is impaired—temporary castration.

Werner (Heidelberg) has had no results from the treatment of bleeding by radiation of the hypophysis (as did Hofbauer). He has, however, obtained a good effect upon the pains of menstruation, and in amenorrhea has brought about the return of the menses.

Gragert (Greifswald) confirmed the decrease of the rate of fall of the blood count.

Vogt (Tübingen) has had results in only 50 per cent of the cases of bleeding treated by radiation of the spleen.

Teilhaber (Munich) agreed with Hofbauer upon the effect of ultraviolet rays and diathermy. Electromagnetic oscillations of various kinds stimulate connective-tissue formation.

Seitz (Frankfurt-on-Main) regards the local effect of the roentgen rays as more significant than the general effect, without deprecating the latter. The dose must destroy the function of the carcinoma cell. It is an error to place the general effect in the foreground, for thousands of carcinomata are healed by local radiation alone. It is necessary to produce a certain degree of swelling. The "carcinoma dose" given for the carcinoma of the cervix does not hold for carcinoma of the breast and other organs. The results of animal experiments and those of work on humans are not to be confused.

Wintz (Erlangen) is of the opinion that connective tissue replaces the carcinoma but does not choke it. The connective-tissue growth is secondary; the products of destruction of the carcinoma stimulate the connective tissue. He expects little from histologic investigations; a biologic reaction must be found, which indicates the reaction between the rays and a carcinoma. After radiation of the hypophysis he once observed dystrophia adiposogenitalis. When the hypophysis received 50 to 60 per cent of the single skin dose, eosinophilia was observed. The hypophysis is endangered by 90 per cent of the skin dose. Wintz admits the possibility of the sensitization of the carcinoma by radiating the hypophysis; which also, however, stimulates the body.

Kehrer (Dresden) holds the adenocarcinoma of the cervix as refractory to radiation. Radium has a better effect than the *x*-ray in carcinoma of the cervix. Radium does not injure the ovaries: the roentgen ray kills them. In old women he recommends ovarian transplantation.

Kraft (Dresden) has seen serous permeation of cutaneous carcinoma metastasis after radiation of the hypophysis. There is an effect on the breast as in gravidity. He warns against large doses upon the brain, fearing late manifestations of harm.

Thies has seen more and larger multiple recidives after insufficient radiation than formerly. In respect to the results of radiation treatment, he notes that adnexa tumors may masquerade as inoperable carcinomata.

Lahm (Dresden) agrees with Wintz as to the theory of healing of carcinoma: first, disappearance of the carcinoma tissue, then invasion of the space by connective tissue. The principal consideration is to alter the degree of maturity of the carcinoma by the radiation. If eosinophile cells appear under the radiation treatment, the prognosis is doubly favorable. The preservation of the trophic nerves plays an important rôle. Lahm therefore does not use an excessively hard ray. A homogeneous deep field, however, must be had. Constitutional treatment is necessary to support the resistance of the body.

Holzbach (Mannheim). More than 80 per cent of the inoperable carcinomata of the uterus die from renal damage by growth of the carcinoma involving and compressing the ureters. He transplants the ureters into the vault of the bladder and prolongs life by preventing their being involved.

Hofbauer states that the ophthalmologists have never noted damage to the brain by radiation of the hypophysis.

Opitz (closing the discussion). Many examples are at hand to show the relation between the hypophysis and midbrain and the vegetative nervous system. Overdosing over the hypophysis is to be avoided. He does not recommend local radiation; he usually uses a combination of radium and roentgen rays.

Winter (Königsberg) Carcinoma statistics. The classification used hitherto: (1) Operable cases. (2) Borderline cases. (3) Inoperable. (4) Terminal. This is not useful. For comparative purposes and for clearing up the problem the statistics must deal with (1) the operable, and (2) the inoperable cases. Even if a few cases do show recidiv later, an observation period of five years suffices. It is false to construct statistics only upon the living; for many which have been counted as successful cases have already relapsed.

On the basis of a questionnaire sent to many university clinics and hospitals, Winter establishes the following cardinal requirements of carcinoma statistics:

1. All cases must be included which come to the clinic.
2. Division into operable (carcinoma limited to the uterus and its immediate vicinity) and inoperable (no kind of operation possible).
3. Enumeration of all fatal cases.
4. Observation period of *five* years.
5. No deductions allowed.
6. In the absolute percentage, all cases to be reckoned as relative percents of a given management.
7. Each author must differentiate, in the absolute number, between subjective and objective.

Discussion: Döderlein recommends a strict adherence to the cardinal principles. Statistics, to be worth anything, must include at least 300 cases. In the future perhaps large numbers of cases will allow statistics upon the result of elective treatments, when the one case is treated by operation, the other by radiation.

Opitz would add to the details mentioned by Winter, the local difference in malignancy of carcinoma. Thus Krönig had 38 per cent of cures in Jena, 5 per cent in Freiburg. Opitz also regards the division of cases into operable and in operable as too nice. The five-year observation limit is too short. Since we have been radiating carcinoma, the case .has changed, and now it is not infrequent for recidiv to occur even after seven years. The most certain criterion is for the patient to remain well all her life.

Stoeckel (Ciel). Palpation is not sufficiently certain to form a basis of statistics. When rectoscopy and cystoscopy are more frequent, there will be better foundation than on palpation.

Von Jaschke (Ziessen) calls attention to the fact that there is an extraordinary difference in operation technique, and that the exact technique must be noted; not every Wertheim operation is a true Wertheim, but it may be reported as such. Krönig operated in Jena much more radically than he did later in Freiburg. This is the explanation for the difference in results mentioned by Opitz.

The presiding officer, Menge, spoke for improved statistics. The present statistics are made upon operative therapy; we paste the new onto the old. Our grandsons will laugh at our statistics because of the ridiculous classifications. Menge pleads for statistics according to length of life: after a certain treatment so and so many live two, three, four years, etc. To the number of the dead should be added the number that have disappeared from observation. Statement should be added as to whether the survivors are found, by palpation, to be free from recurrence.

At the conclusion, upon resolution of the society, the statistics worked out by Winter were accepted as the ones to be employed, perhaps in connection with others.

Dandy, Walter E. Localizing brain tumors in comatose patients. *Surg., Gynec. & Obst.*, May, 1923, xxxvi, 641.

The author gives in full a detailed statement of his method and the indications for the determination of communication between the cerebral ventricles and the estimation of their position and size without the injection of air. Roughly estimated, not more than 50 per cent of all brain tumors are localizable by neurological and roentgenological examinations, and it is for the localization of the other half that cerebral pneumography is of the greatest value.

The emergency method proposed when cerebral pneumography is not possible is to estimate the size, position, and intercommunication of the ventricles by aspiration of the fluid in the lateral ventricles (and at times from the cisterna magna). Puncture of both ventricles is always necessary.

The article is abundantly illustrated by drawings, photographs and roentgenograms.

The author expresses the hope that he may publish in detail a large series of brain tumors in which the use of cerebral pneumography has been the means of localizing the growth.

Guisez, J. Radium treatment of cancer of the esophagus. *Presse méd.*, Feb. 28, 1923, xxxi, 193.

Guisez since 1909 has treated 180 cases of cancer of the esophagus with radium rays. During the first few years the benefit was only palliative, but during the last three years a number of apparent cures have been realized. This improvement in results he believes depends upon improvement in technique. In all the cases treated during the last six months not a trace of cancer can be seen and all difficulty in swallowing has disappeared. The endoscopic pictures of a number of cases are reproduced and complete details of treatment and dosage are included in the text.

Rieder. Irradiation sickness. *Strahlentherapie*, xii, p. 573.

The general manifestations of irradiation sickness ("Roentgen Kater" of the Germans) can be diminished by means of thorough ventilation of the radiation room. As the author considers the electrical charging of the patient as one of the causes of after-sickness, he recommends that the electricity be grounded through a cable applied at the thigh and connected with the water conduction. Great caution is needed on account of the danger of short-circuiting. The grounding is preferably employed only with a minimum distance of 40 cm. between the focus and the skin. Unnecessarily large fields should also be avoided. The radiated body-space should be restricted to the smallest possible measure. By means of administration of laudanum-scopolamin, it is possible to reduce the general manifestations to a minimum degree, also in radiations of the splanchnic region where there is a special tendency to after-sickness.

Lotsy. A case of left-sided renal stone together with gall-stones in the colon. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1923, xxx, 214.

A native Egyptian was referred to the author in Cairo for examination of the left kidney. A shadow of a large renal stone was found, and there were also several shadows lower in the abdomen which changed their position readily. A history of severe epigastric cramps three or four weeks before, followed by jaundice, was then elicited. Lotsy concluded that the shadows in question were due to gall-stones which had lain meanwhile in the cecum, but had been mobilized by the castor-oil taken the night before examination. He gave the patient a physic and directed him to wash all stools through a sieve. However, the patient was not very bright and on his return he said that he had found nothing. Reexamination showed that the shadows in question had disappeared, though the renal stone shadow was still there. Lotsy compares the shadows to those shown by Carman in his text (2d edition) in Figures 355, 358, 359 and 361.

Kleinberg, S. Periosteal chondrosarcoma. *Internat. Clin.*, 1923, ii, 33d series, 247.

The patient, a man nineteen years old, was well until he suffered slight trauma to the knee two months before he was seen by Kleinberg on December 9, 1922. The writer therefore regards the sarcoma as due to the trauma, which consisted of striking the knee against a ladder. As this injury occurred while the man was at work, there arises the question of compensability under the laws of New York.

A small shadow of bone density, shown by oxygen inflation of the joint to be continuous with the patella, diverted the attention of the roentgenologist and all the examining physicians away from the area of density in the head of the tibia that bespoke the tumor. Kleinberg diagnosed osteomyelitis or neoplasm from the films the patient brought with him, and on December 12, evacuated a deposit of gray friable tissue, underlaid by eroded dense bone, some of which was removed. The slides of the tissue, which was very cellular with but little stroma, were examined later by Dr. James Ewing, whose diagnosis was periosteal chondrosarcoma. The dense shadow in the patellar region, out of the tumor zone, was found due to cartilage.

A mid-thigh amputation was performed on December 21, 1922, and as late as July 14 of the present year (personal communication to the abstractor from Dr. Kleinberg) the patient was free from evidence of local or metastatic recurrence. When first seen he was pale and thin. He now weighs several pounds more than before the amputation, and appears to be entirely well.

Schreus. Studies on static electricity of the roentgen tube. *Fortschr. a. d. Geb. d. Rontgenstrahlen*, xxviii, Hft. 2.

Besides the gliding sparks which pass on the outer wall of the tube from the anticathode to the cathode, there are the cathode neck-sparks, which originate at the cathode and terminate in the insertion of the cathode neck at the tube-sphere. These sparks give a strong light and are accompanied by a loud crackling sound. The danger of penetration may be prevented by lengthening the cathode-neck. At the same time, the author carried out investigations concerning the distribution of the charge in the tube in general. For details, the reader is referred to the original article.

Saberton. Ante-operative *x*-ray irradiation. *Arch. Radiol. & Electroth.*, Aug., 1922, p. 91.

In discussing a paper on the employment of deep radiotherapy by several French authors, Saberton stated that the time has not yet come when we can feel justified in advising our patients with an early operable growth to have radiation treatment rather than operation. In favor of ante-operative radiation we have the fact that the patient is in a better state of health to stand massive dosage than would be the case after an operation, and also there is less risk of a surgeon spreading active cancer cells about the body by the surgical trauma he has to carry out. Against ante-operative radiation we have the fact that a patient ought to wait for four to six weeks after a massive radiation before an operation is undertaken. In many cases, both ante and post, radiation treatments in conjunction with burying emanation needles at the time of operation will have to be carried out.

The question of dosage and the advantages and disadvantages of small and large radiation fields must be carefully considered in each individual case, and a line of treatment adopted to suit the particular case we have in hand. The theory of an antitoxin being formed as a result of nature's efforts to cure the disease is a fascinating one.

Hirsch. Experiences with the Loose filter. *Strahlentherapie*, xii, 560.

Loose attributes his unparalleled success to the employment of a crystal filter utilized by him, the exact composition of which is not stated. Hirsch worked with this filter, which, in his opinion, corresponds with respect to its power of absorption to an aluminum filter of about 6 mm. thickness. The biological effects, as was to have been anticipated, differed in no way from those of ordinary filtration. Sensitive tumors subsided, whereas obstinate tumors proved refractory.

Davis, George G. Osteosclerosis fragilis generalisata. *J. Exper. M.*, Mar. 1, 1923, xxxvii, No. 3, p. 449.

Albers-Schönberg's disease, or marble bone, is a rare condition characterized by a pathological fracture following a rather trivial injury, the fracture occurring as the result of a rather obscure bone condition termed osteosclerosis fragilis generalisata. Only 9 other cases of this disease have been reported, all in foreign literature.

An *x*-ray summary of the literature is appended to the report of the case. The article constitutes a very important contribution to roentgen literature.

Kothen. The measure of the percentage depth dose with Kienböch strips after the method of Baumeister. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, Hft. 2.

From his experiments, the author draws the conclusion that with hard rays, such as are employed for the treatment of carcinoma, the Baumeister procedure is insufficient because it leads to overdosage. Also in the scope of softer rays, there still remains the difficulty of accurate registration, so that this procedure can be regarded only as an emergency measure, until the iontoquantimeter becomes so well equipped that it can serve as a general adjunct of practical roentgenology, due to its convenient manipulation and reasonable price.

Portmann, U. V. The efficiency of radiation therapy. *J. Lab. & Clin. M.*, Aug., 1923, viii, 716.

The author concludes that in order to obtain the best results in the treatment of malignant diseases by radiation the physical principles of the production and action of the *x*-rays and of radium must be understood.

It is usually impossible to deliver a therapeutic dose of *x*-ray radiation to deeply situated areas. The large deep doses which were first reported are not obtainable under present practical working conditions.

Radiation by either the *x*-rays or radium alone is insufficient; they should be used in proper combination.

The danger of insufficient radiation is as great or greater than that of overradiation; the desideratum is the administration of the proper dose at the first treatment.

Drüner, L. The technique of fluoroscopy: description of a new appliance. *Deutsche Ztschr. f. Chir.*, July, 1921, clxv, 275.

Fluoroscopic technique is threatened with the danger of becoming dependent upon large, expensive, stationary apparatus, which interferes with the movements of the surgeon, and moreover, does not entirely meet operative requirements. Drüner describes a simple appliance, manufactured by the hospital carpenters and engineer, destined for roentgenoscopic operations. The usefulness of this appliance is illustrated by four case histories. The outfit consists of three small exchangeable tables, under which the entire roentgen apparatus is lodged. The sequence of the tables may be changed according to requirements. I. Board and interruptor; II. Induction; III. Tube on a slide. The table bearing the tube is always placed under that portion of the body which is to be operated upon. The small apparatus comes from the factory of Siemens and Halske. Conduction from each plug with 6 ampere and 110 volt continued current. The essential feature is the full utilization of even a small outfit. It is most important for the appliance to permit the adjustment of all positions which are indispensable for the surgeon, such as the breech and back position, the breech-abdominal position, and elevation of the pelvis.

Hirsch, Henri. Concerning roentgen sickness and roentgen cachexia. *Deutsche med. Wchnschr.*, Dec. 8, 1922, p. 1646.

The author points out that the so-called Roentgen Kater (*x*-ray morning after sickness) and roentgen cachexia are manifestations of one identical injury, in the sense that a reparable damage of the endocrinic apparatus leads to the transitory phenomena of *x*-ray sickness, whereas an irreparable damage of the internal secretory system finds its expression in chronic cachectic conditions. Roentgen "sickness" is an acute manifestation, which originates after the application of definite *x*-ray doses, in excess of a certain limit, and is essentially dependent in its degree on purely individual fluctuations corresponding to the constitutional diathesis of the radiated individual. This acute condition subsides sooner or later, according to the patient's constitution, but may persist up to six weeks in variable intensity. The blood picture after intensive radiations shows at first, a slight leucocytosis, which, later on, passes into leucopenia; the lymphocytes gradually increase at first after the radiation and then diminish very considerably. The blood picture gradually recovers, and at the end of about four to six weeks, the patient presents a normal blood formula, besides the physical recovery, in favorable cases. Otherwise, the condition passes into the picture of cachexia, which here must be referred to a permanent damage of the endocrinic system through the action of the roentgen rays.

Bartram, Gerhard. Localization of the portio vaginalis in gynecological deep therapy. *München. med. Wchnschr.*, Feb. 9, 1923, p. 178.

For the accurate localization of the object of radiation, so that the central ray may reach its middle—an essential requirement, especially in the radiation of malignant tumors—the author has constructed a simple "directing circle," based on the ordinary circle used for pelvic measurements. This small instrument may serve for the determination of abdominal, dorsal, and also vulvar fields. Although it is planned primarily as an adjuvant in the radiation of carcinoma of the portio, its employment permits an essentially more accurate dosage also in radiations of the uterine fundus and ovaries than is possible by means of a mere estimate of the position of these organs. Its usefulness in carcinoma of the rectum is very evident.

Minet, H. Calcified hydatid cysts of the kidney. *J. d'urol. méd. et chir.*, 12, p. 13.

Description of a calcified hydatid cyst, which had developed in the lower pole of a calculous kidney. The roentgenogram showed, aside from two shadows of calculi, a large rounded mottled shadow with local lighter spots, corresponding to the irregular distribution of the calcium deposits within the cyst.

Wetterer. Roentgen treatment of the complications of gonorrhea. *Strahlentherapie*, xii, 469.

In numerous complications of gonorrhea, Wetterer had very excellent results with *x*-ray radiation. In gonococcal arthritis, the radiations should be instituted as promptly as possible. Equally good results were obtained in all joints. The monoarticular and the polyarticular cases have an equally favorable prognosis. Cases of periostitis are also well adapted to this treatment, especially in the early edematous stage. There was no failure among 75 cases of gonococcal disease of the organs of motion. The radiations are applied with highly filtered rays. The dose remains below the erythema limit. The many other complications of gonorrhea, in which good results may be obtained with *x*-rays, are of less surgical interest.

König, Fritz. Operation in an irradiated field. *Med. Klin.*, 1921, No. 43.

The author has noted that after slight and more extensive operations in regions that have been previously treated with the roentgen rays, the wound has not healed normally; necrosis has occurred, sometimes even suppurative breaking down of tissue; but after a period, the necrotic material was cast off and normal granulation took place. The author believes that after intensive roentgen radiation there is a latent weakness in the irradiated tissue, varying according to individual predisposition, which does not become manifest unless some special provocation, such as operation, leads to necrosis.

Holzknecht. Dosage in deep roentgen therapy from the biological point of view. *Vox med.*, 1921, iii, No. 3.

Where it is necessary to destroy tissues, as in carcinoma and most malignant tumors, a single large dose of the roentgen rays is indicated. In tuberculosis, on the other hand, experience has shown that repeated small doses are more effective. It is not necessary to destroy, but rather to strengthen the resistance of the organism. In the more severe types of tuberculosis, the dosage should be very carefully adjusted. In irradiating glands with inner secretions, their function should be disturbed as little as possible. The dosage should be carefully adjusted in each case by beginning with small and medium doses, and observing results.

Jüngling, Otto. Roentgen treatment of surgical tuberculosis. *Med. Cor.-Bl. d. württemb. ärtzl. Landesver.*, xci, Nos. 38 and 40.

Roentgen rays are not a specific in the treatment of tuberculosis. They do not directly injure the tubercle bacilli, nor do they destroy the tubercles. The epithelioid cells as derivatives of connective tissue are very resistant to the rays. The higher doses do not improve the results; on the contrary, small doses (20 to 50 per cent of the skin erythema dose) are more effective than larger doses. Apparently, the rays act upon the lymphocytic elements of the tubercle, which are very radiosensitive, and are destroyed by the smallest doses. With tuberculous lymph glands, roentgen-ray treatment is the method of choice; general constitutional treatment for tuberculosis should be combined with the local treatment. Results with tuberculous peritonitis are also good. In unilateral tuberculosis of the kidneys, as well as in unilateral tuberculosis of the epididymis, operation is indicated, in order to prevent the spread of the infection. Postoperative ureteral fistulae respond readily to the roentgen ray: bladder tuberculosis, less well. In bone and joint tuberculosis all sequestra should be surgically removed. Iselin thinks that on technical grounds, greatly enlarged joints should not be *x*-rayed; the author, however, has found *x*-ray treatments suitable in certain cases of this type.

The method ensures a fairly accurate dosage, permits the working-out of the optimum dose and a comparison between the results of different therapeutists, and prevents late roentgen injuries, which is of special importance.

Spinelli, M. Contribution to the roentgen and radium treatment of uterine cancer. *Actinoterapia*, 1921, ii, No. 3.

The author reports early results in radium-roentgen treatment of uterine cancer. Clinical cure was obtained; in precancerous stages in 100 per cent (18 cases), in corpus carcinoma in 87 per cent (of a total of 8 cases), in diffuse cervix carcinoma on the borderline of operability in 75 per cent (of 9 cases), in operable carcinoma or recurrences in 48 per cent (of a total of 56 cases). Radium treatment alone was used in the precancerous stage, but radium treatment (4,000 to 10,000 mg. hrs.) combined with intensive roentgen-ray treatment, using seven fields, in all other cases.

Groedel. Encapsulated pleura as seen roentgenologically. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 2.

The author describes the roentgen-ray appearances of encysted pleurisies, which vary according to their site. Case reports and roentgenograms are presented with the pleural exudate above the right upper lobe, with interlobular pleurisy, traumatic exudative pleurisy, locular pleural exudates, and exudative mediastinal pleurisy, and the difference between these conditions and other similar pathological conditions is illustrated and explained (abscesses, echinococcus cysts, hematoma, etc.) Some of these conditions have not been demonstrated elsewhere. Early roentgenological diagnosis may often save life.

Hammer. Roentgen treatment of scleroderma. *München. med. Wchnschr.*, 1921, No. 35, p. 1109.

The author has observed marked improvement in many cases of scleroderma after roentgen-ray treatment of the thyroid and thymus. This was especially true of cases with goiter and symptoms of thyrotoxicosis. Technique: 30–35 cm. spark distance, 170–180 kv., 2 ma., *heavy metal* filters, about 1/5 skin erythema dose, every two to four weeks.

Wille, O. The value of the tube beneath the table in deep roentgen therapy. *München. med. Wchnschr.*, 1921, p. 1254.

For the treatment of large fields, the author has adjusted a tube fixed under the *x*-ray table for therapeutic purposes. In this way two fields can be treated simultaneously. With slender Coolidge tubes, the apparatus is easy to adjust. This arrangement is of special value if used with the Dessauer-Warnekros apparatus. The entire arrangement is shown in an illustration.

Rzewuski. Osmo regulation of roentgen tubes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 3.

The author reports on his experiments with hardening roentgen-ray tubes that are too weak. The method was described by the English writer Kaye as early as 1898. If the regulating palladium tube is heated only with the point, that is, the oxidizing portion of the flame to glowing heat, then the hydrogen in the tube is burned and the tube becomes harder. Heating to 200° is sufficient. The author treated over-regenerated tubes that he wished to save with the palladium regulating tubes.

Ramond, F., Jacquelin, Ch., and Borrien. Gastric spasms. *Presse méd.*, July 20, 1921, lviii.

According to the anatomical conditions demonstrated, there are three types of gastric cramps—due to cardiospasm, gastrospasm (involving the region of the fundus) and pylorospasm. The Braun or Gubaroff valve which some authors believe to be present at the cardia as a cause of spasm and aerophagy is found only very rarely at autopsy. On the other hand, there is in many cases a mechanical cause for cardiospasm in that the abdominal portion of the esophagus is abnormally kinked. The functional symptoms of cardiospasm are slight; occasional local pain, sometimes a painful pressure point over the ensiform process, a feeling of fulness after eating, no dysphagia. The roentgenogram is typical, showing dilatation of the esophagus, and a wide bismuth column, broken up by air spaces which pass slowly along the gastric walls in the stomach, although the pressure of the hypertrophied esophageal musculature is sufficient to push this column forward and overcome the obstruction at the cardia.

Gastrospasm, which is usually combined with pylorospasm, is occasionally observed alone, chiefly in acute gastritis, also in ulcer of the lesser curvature, and in duodenal ulcer, in cholelithiasis, renal stone, and appendicitis, and in neuropaths. Gastrospasm alone causes no subjective symptoms and is shown only by roentgenological examination (increased peristalsis, hour-glass stomach). On the other hand, gastrospasm combined with pylorospasm causes symptoms of pylorospasm and pyloric stenosis, cramp-like pains, feeling of fulness, regurgitation of air and food contents, excess or absence of peristalsis, so that the stomach appears fixed "in systole." In pylorospasm alone the subjective and objective symptoms are the same. In the roentgenological examination, the bismuth meal has a soothing effect, and hence slight spasms are often not visualized. The roentgenogram shows that only a small part of the gastric content passes into the duodenum and there remains unchanged, although the stomach may show peristalsis. Brugel's symptom is also evidence of pylorospasm. The administration of suprarenin (0.5 gm.) increased the spasm: atropin diminishes it. Therapeutically, in addition to the determination of the underlying cause and the corresponding dietetic treatment, belladonna is chiefly indicated, also benzyl benzoate, morphin and opium are less valuable.

Knox, R. Treatment by *x*-ray and radium. *Edinb. M. J.*, New Ser., May, 1921, xxvi, No. 5.

In roentgen and radium therapy, the decisive factor is the wave-length, so that rays of different wave-lengths must always be available for the various requirements. All discussions as to the greater or less value of *x*-ray as compared to radium are therefore useless, the essential point being that with available apparatus, no short-wave rays can be produced, corresponding to the gamma rays of radium. The utilization of radium and roentgen apparatus seems to be the most rational procedure. Superficial lesions are most favorably influenced, and there is in addition the advantage of direct observation. It must be kept in mind, however, that certain malignant formations, such as rodent ulcer and epitheliomata, may prove rebellious against all radiation therapy. Overdosage is cautioned against in alopecia areata, where the *x*-rays are always efficient. In rodent ulcer, the frequent recurrences after simple roentgen radiation are noteworthy, whereas radium radiation yields more durable cures. In lupus, radiation with radium, roentgen and violet rays is justified, but special precautions are needed on account of the damage to the skin due to the disease. The same remark is true for acne, where vaccination and medicinal therapy may also be successfully employed. Hyperidrosis is favorably modified by *x*-rays. Blood diseases associated with enlargement of the spleen are temporarily improved by *x*-rays in the same way as through splenectomy, which likewise yields no permanent cures. In exophthalmic goiter, long-continued roentgen radiation together with rest and medicinal therapy may be equally as successful as operative treatment. Inflamed and enlarged glands are rapidly reduced in size through roentgen radiation, also lymphadenomata and sarcomatous glands, although recurrences rapidly occur in the latter, which finally cease to react to the radiation. Tuberculous glands diminish slowly in size, and rarely disappear entirely, often showing a tendency to recurrence, so that the removal of the reduced glands is recommended. Carcinomatous glands are hardly affected by radiation as a rule. Uterine myomata are favorably influenced in a general way with respect to reduction in size, and even more so with respect to hemorrhage. In malignant tumors, preliminary radiation before the operation enters into consideration; furthermore, postoperative radiation, radiation of recurrences and ray treatment of inoperable cases. Preliminary radiation is recommended in all cases when the operation is not essentially delayed by the radiation. Preceding the radical operation for mammary cancer, radiation seems to be especially valuable, as the lymph glands are modified by the radiation, and epilation of the axilla is produced. Also postoperative radiation enters primarily into consideration for mammary carcinomata. Radiation treatment should be instituted promptly and carried out systematically. The same is true for recurrent and inoperable tumors, in which the collaboration of the practitioner, the surgeon and the roentgenologist may be expected to furnish good results.

Glover, Donald M. Osteopsathyrosis: Report of a case. *Arch. Surg.*, Nov., 1922, v, 464.

The author reports a new case of osteopsathyrosis with roentgenograms of 11 different fractures in the same patient occurring between the age of nine months and his death at seven and a half years. A brief summary of the literature is recorded. Excellent roentgenograms accompany the article, which discusses not only the history of this patient but also terminology, classification of cases, etiology and pathology. As to symptomatology, there are no constant symptoms other than the tendency toward frequent fractures. In some of the earlier cases the appearance of the patients conforms more or less to type. They have a relatively large head, small chest and a protuberant abdomen. The later cases, however, may show no recognizable peculiarities of form.

The roentgen-ray findings have been summed up by Locke as follows:

"(1) A high degree of osteoporosis uniformly affected the entire skeleton, the variations in density giving a mottled appearance; (2) marked deformities of the long bones of the extremities, usually of the angular type, due to fractures, rarely also some actual bowing; (3) apparently normal size and shape of bones, except as altered by fractures and resulting callous formation; (4) often excess callous formation with variable degree of calcification. A transverse line of decalcification is often seen at the point of previous fracture; (5) the epiphyseal line is straight, cartilage is always thin; (6) a very faint shadow is given by all the bones, frequently scarcely more dense than that of the surrounding soft parts; (7) the cortex is thin, irregular and deficient in salts; (8) the spongiosa of both epiphysis and diaphysis is extremely faint with entire absence of normal markings; (9) the medullary cavity is very irregular in outline and dilated." These changes are considerably less marked in some of the milder cases, such as the one described in this article.

Metabolism studies have suggested that calcium metabolism may have some bearing on this type of bone fragility as well as on the deformities of rickets.

The outlook in cases of osteopsathyrosis is poor, in spite of the fact that a few patients have grown to adult life, apparently overcoming the bone fragility from which they suffered in earlier years. Most of the patients that survive are deformed by earlier fractures. Few fractures occur after the patient is in the early twenties, and after that time the prognosis is fairly good. Below that age, however, the mortality is high. The mortality is almost 100 per cent in the fetal type, the majority dying in utero.

The diagnosis is usually perfectly clear, because there is no other congenital disease in which multiple fractures occur. Rickets and syphilis occasionally cause fractures in young children; but rarely more than two or three fractures occur in the same person as a result of these affections.

Weis, Howard A. A contribution to the study of the effects of radium upon rabbit ovaries. *Surg., Gynec., & Obst.*, Mar., 1923, xxxvi, 373.

In the experimental work the dosage of radium used was always 600 mgm. hours, that dosage being selected because it is conceded by most authorities that 600 mgm. hours of radium applied intrauterinely will be usually sufficient to produce an amenorrhea for several months, and sometimes permanently; the generally accepted theory being that this result is due to the fact that the radium rays destroy all the maturing follicles most advanced in development, the return of menstruation occurring because the more immature follicles had not been destroyed. When these matured, menstruation resulted. But this explanation is contrary to the biological law which states that the less mature the cell, the greater its susceptibility to disintegrating influences.

For most of the exposures 50 mgm. of radium was employed in the form of radium barium sulphate in two 25-mgm. tubes, filtered with a glass, a silver and a brass screen, and this inserted in a rubber tube of 1 mm. thickness. The tubes were then fastened to a lead frame by adhesive, and this fastened by adhesive and a wide gauze bandage, as nearly over the rabbit's ovary as could be determined. The dose was 600 mgm. hours.

The complete details of the treatment are given in the body of the article. The author found that in none of the ovaries was there any change in the single row of germinal epithelium after exposure to radium and no evidence of any obliterative endarteritis. Six ovaries showed little or no change evident in the connective tissue cortex; but ten others showed an increase in the number of cells in this area, and four showed a definite widening of this zone. Certainly the author found that the young and early maturing ova had not been damaged. Thus the author did not feel justified in concluding that 600 mgm. hours of radium had any ultimate detrimental effect upon rabbit ovaries.

The author ventures the opinion that when radium is given intrauterinely for a case of menorrhagia, for example, the resulting amenorrhea is not due to the effect of the radium upon the ovarian follicles, but to the effect upon the endometrium which receives a severe burn from the radium. If the burn be extensive enough a permanent amenorrhea results; and if not so severe, the amenorrhea persists for only a few months.

The above views constitute a definite departure from the accepted theories of the effect of radium.

Schmidt, Ernst Albert. Experimental and histological investigations concerning the effect of roentgen rays upon the staining properties of tissue. *Strahlentherapie*, xii, 517.

Radiated and unradiated mice were stained with trypan-blue while living; two days after the last injection, one stained animal and one control animal were killed. Microscopic examinations were made of the skin, mucosa, liver, spleen, testicles or ovaries, respectively, heart and muscles, brain, bone-marrow and blood. The radiated animals took the blue stain more rapidly and intensively. The organs were stained to a very variable degree of intensity. Details concerning the findings in the organs must be looked up in the original. The staining was expressed as a granular staining and as diffuse protoplasmic staining. The various organs showed differences with respect to the intensity of the coloration, with respect to the intracellular distribution of the pigment and with respect to the distribution of the color among the individual kinds of cells. In a series of experiments, a different behavior with respect to the above-mentioned points was noted in radiated as compared with unradiated animals, without its being possible to establish any deviation from the normal standard anatomo-histologically, by means of the customary post-mortem staining methods. The different behavior is regarded by the author as a change of cellular function, the various modifications being interpreted by him as follows: Increased accumulation of pigments in the form of granules is considered as an increased function; diffuse coloration of the protoplasm, as a slight damage; nuclear staining as a post-mortem phenomenon and as the expression of a grave cellular lesion. In view of the fact that all these differences in staining take place in the connective tissue, this must be considered to play an important part in the action of the rays. Vital staining, according to these findings, appears to be a valuable adjuvant for the representation of slight cellular changes of functional character.

Voorhoeve, N. The roentgenologic symptom-complex of horseshoe kidney. *Fortschr. a. d. Geb. d. Röentgenstrahlen*, 1923, xxx, 201.

In the *Nederl. Tijdschr. v. Geneesk.*, 1916, ii, 1250, Voorhoeve has told how he diagnosed horseshoe kidney in a patient seen in Amsterdam in 1915. In 1919 he saw a second patient in whom he succeeded in making this diagnosis. Both patients came to operation for removal of a demonstrated stone. In the first case the connecting bridge had not been visualized, and operation showed it to be a narrow fibrous strand. In the second case it was partially visualized, and operation showed it to be large and thick.

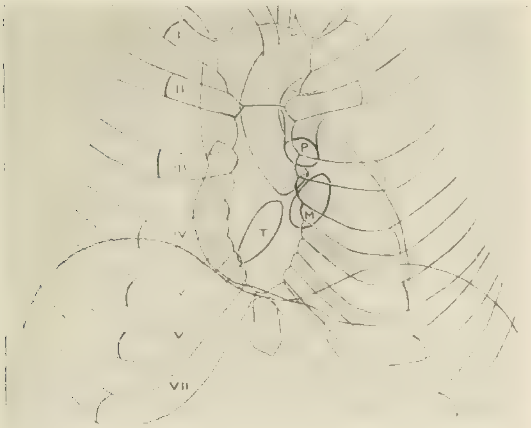
The diagnosis therefore depends not necessarily upon visualization of the bridge, but on alterations of position and mobility of the kidneys due to its presence: (1) The median border of the kidneys parallels the vertebral column, or makes a much diminished angle with it, and (2) is closer to it than normally. (3) There is bilateral renal ptosis, which may be very marked. (4) The kidneys make no lateral excursion on respiration. In the author's first case, the vertical mobility was preserved, but this is not usual. (5) The lower pole can be demonstrated as ventral to the vertebral column. For this, the comparison of paired exposures in the ventrodorsal and the dorsoventral positions is of value.

In the absence of vertical mobility, not even the added aid of pyelography will always differentiate from a pair of congenitally dystopic kidneys that adhere to their surroundings. However, an equality of the ptosis makes horseshoe kidney the more probable.

The author refers to reports of a case of Quartero's and one of van Hasselt's in which his method established the diagnosis, and to a report by de Groot of the agreement of findings in the examination of a patient in whom operation had already demonstrated the presence of a horseshoe kidney. He emphasizes that the method will diagnose the condition even when it has not been suspected.

LeWald, Leon T. The relation of the heart, pericardium and the heart valves to the anterior chest wall. *Arch. Surg.*, Jan., 1923, vi, 89.

The author calls attention to the inaccurate older methods of locating the valves of the heart by dissection, and then describes a method of localization by means of teleoroentgenography in a cadaver in which wires had been placed in the valve orifices by Dr. H. D. Senior, Professor of Anatomy at Bellevue Medical College.



Outline drawing of teleoroentgenogram and stereoscopic roentgenograms. The position of the valves T (tricuspic), M (mitral) and P (pulmonary) may be noted. The aortic valve is indicated by the beginning of the aorta.

The frozen thorax was cut accurately, by means of a band saw, in the frontal plane so as to open both auricles from behind, without interfering with the contour of the heart. In the intact interior portion of the thorax, the mitral and tricuspid valves were readily accessible. Wires were bent so as to fit accurately the groove corresponding to the attachment of the valves to the heart wall. The wires were placed in position from the auricle, and in the case of the tricuspid valve, fixed by means of two sutures. The cusps of both auriculoventricular valves were found to be in apposition. The interior of the aorta was reached through the anterior wall of the left auricle. The region of the pulmonary valve was made accessible by removing the remainder of the left lung and cutting the artery longitudinally from the left side. Wires were shaped to fit the aortic and pulmonary orifices and placed so that they were in contact with the deepest part of each of the semilunar valve cusps, which provided excellent guides in placing the wires. After placing the pulmonary ring, the cut edges of the vessel came into position. The accuracy of the position of the wires was verified after roentgenograms had been taken.

The apex is in the fifth intercostal space, from 7.5 to 8 cm. (3 to 3¼ in.) from the median line. The base corresponds to an imaginary line drawn from a point 1 cm. (⅖ in.) below the second left chondrosternal articulation, and 3 cm. (1⅕ in.) from the median line to another point the same distance from the median line, 1 cm. above the right chondrosternal articulation. The margo acutus, or lower border, corresponds to a line drawn from the apex through the xiphisternal articulation to a point on the sixth costal cartilage, 2 cm. to the right of the median line. The right border of the heart may be indicated approximately by an imaginary line (slightly convex to right), joining the right ends of the first and second lines. The left border corresponds to a line (slightly convex to left) joining the left end of the first line to the apex.

If a line is drawn from the upper margin of the left third chondrosternal articulation to the right edge of the sternum in the fifth intercostal space, the upper end of the line will lie over the center of the pulmonary orifice, and the lower two thirds of it (approximately) will overlie the main axis of the tricuspid orifice. The aortic orifice is immediately to the left of the above line, with its center at the left edge of the sternum, opposite the third space. The mitral orifice is very largely behind the third left interspace; its upper end is behind the third cartilage, its lower end behind the left margin of the sternum, opposite the fourth cartilage and space.

LEWALD, LEON T., and GREEN, NATHAN W. The differential diagnosis between tuberculosis and lung abscess. *Arch. Surg.*, Jan., 1923, vi, 303.

The authors record a group of 8 cases of abscess of the lung successfully operated upon. The cases are classified as follows: (1) bronchiectasis; (2) bronchiectatic abscess; (3) suppurative pneumonitis; (4) extrabronchial abscess.

Several of the cases had histories which had led to an erroneous presumption of pulmonary tuberculosis, largely because of the presence of blood in the sputum, persistent cough and loss of weight. The authors call attention to the accuracy of the roentgenographic diagnosis of abscess of the lung and its differentiation from tuberculosis when properly interpreted. The attention is also called to the fact that the sputum does not always have a fetid odor in abscess of the lung. Clubbing of the fingers is one of the most definite appearances. Repeated negative examination of the sputum for tubercle bacilli confirmed the diagnosis of lung abscess, in spite of the fact that three of the cases had been referred from tuberculosis clinics. The origin of the abscess in each case was of postpneumonic or postoperative nature; two cases followed tonsillectomy and one followed an operation on the gall-bladder.

KAESS, F. W. Temporary sterilization of the parotid by *x*-rays in the treatment of salivary fistulae. *Zentralbl. f. Chir.*, Jan. 6 and Apr. 21, 1923, pp. 14 and 641.

Parotid fistulae have occurred frequently since the World War, as a result of war wounds. Surgical treatment of these fistulae has not proved very satisfactory. Kaess reports 2 cases treated with *x*-rays. In the first case, bilateral parotid fistulae resulted from a gunshot wound; the fistula on the left side was cured by operation. Operation on the right side, however, was not successful, and saliva continued to flow out of the fistulous opening. One treatment with *x*-rays was given with the following dosage: 120 F., 24 cm. skin target distance and 3 mm. aluminum filter. Within a few days all flow of saliva had ceased, and in a month the fistula was entirely closed. In the second case, there was a parotid fistula on the left side due to an injury to the face from a shell splinter. The wound had healed except for the fistula, from which there was a constant flow of saliva that had caused eczema of the cheek. This case had been treated by Leriche's method of division of the auriculotemporal nerve; this had resulted in temporary diminution of the flow of saliva, which had, however, increased again. A single treatment with the *x*-rays was given with a higher dosage than in the previous case, 150 F., 25 cm. skin target distance and 3 mm. aluminum filter. The flow of saliva ceased in a week and the fistula closed in two weeks. A month after treatment, the patient reported that the eczema was entirely healed, and he no longer suffered from dryness of the mouth, which had been constant previous to the closing of the fistula.

This method of treating parotid fistulae has been very little used; the author finds only one previous reference to it in the available literature. He recommends it, however, not merely in the more persistent types of fistulae, but also as an adjuvant to any operative treatment, especially as it is simple and conservative.

Kaess notes that since his report, Fraenkel of Charlottenberg has told him that he (Fraenkel) discussed the roentgen-ray treatment of parotid fistulae to diminish the secretion, and thus aid the healing of the fistula, in his treatises on "Roentgen-ray treatment of war wounds" (*Strahlentherapie*, 1916, vii), and "Treatment of severe fractures with stimulative roentgen-ray doses" (*Med. Klin.*, 1915, No. 8).

SCHAEDEL, H. Radiation as an aid in the operative treatment of parotid fistula. *Zentralbl. f. Chir.*, Apr. 21, 1923, p. 640.

Schaedel reports one case of parotid fistula on the right side, resulting from a war wound; the flow of saliva was always increased when the patient was eating. Operative treatment had not been successful. The fistula was entirely healed by a roentgen-ray treatment with 25 cm. skin target distance; 160 kv., 2 ma., 0.5 zinc, 1.0 aluminum filter. A year later, it could be demonstrated that the right parotid gland was functioning.

NORDENTOFT, SEVERIN. New points in the treatment of uterine cancer with radium. *Ugesk. f. Laeger*, 1921, lxxxiii, 75.

The author in a lecture discusses modern viewpoints for the radiation of cancer of the uterus. Radium rays are preferable to the *x*-rays (investigations of Aurich in Vienna). Radium capsule, for the protection of rectum and bladder; 7 mm. gold filter, in front and behind. Butterfly shape of area for transverse incision. In order to avoid a rotation of the capsule, Nordentoft employs elliptic capsules. Radiation (once) for twenty-two and one-half hours. Fifty milligrams radium, respectively, is inserted into the cervix, and through incision internally at the tuberosity of the ischium towards the obturator foramen.

Schweitzer. Life expectancy after radioactive treatment of carcinoma of the cervix. *Strahlentherapie*, xii, p. 501.

Inoperable carcinomata: 32 per cent primary cases. Operable carcinomata: 75 per cent primary cases. In the inoperable cases, 4.9 per cent permanent cures were obtained. For the operable cases, the permanent cures (six to seven years) amounted to 25 per cent. The author recommends operation followed by combined radium and *x*-ray treatment. In cases which have not been radically operated upon, supplementary after-radiation is still fairly promising. So-called "preparatory" radiations before the operation are cautioned against, on account of the danger of damage to the tissues.

Lahmann. Combined roentgen and sunshine treatment of granuloma. *München. med. Wchnschr.*, 1921, p. 1249.

In a case of rapidly growing malignant lymph granuloma, roentgen-ray treatment alone had no therapeutic effect. On the contrary, the blood picture and the clinical condition were worse after each radiation. After the institution of intensive light treatment, with sunlight or the Alpine light, the blood picture, the patient's general condition and the reaction of the roentgen rays were all improved. The tumors were rapidly reduced in size during a febrile reaction, so that after a four months' treatment, the patient seemed entirely normal. Since there has been no recurrence in two years, this case may be regarded as probably cured.

Rydgaard, Frode. Vaquez' disease cured by *x*-ray treatment. *Hospitalstidende*, 1921, lxiv, Nos. 24 and 25.

Report of a case of polyglobulia megalosplenica (Vaquez' disease) in a woman of thirty-seven years, cured by *x*-ray irradiation. The author considers splenectomy as contraindicated in Vaquez' polyglobulia without complications. When radiation of the spleen alone is not sufficient, it may be combined with radiation of the long shaft bones.

Weil. A rare roentgen finding in a child's femur. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 2.

The author reports a type of ossification process in the head of the femur, apparently never described previously: "Above the unchanged epiphyseal line there was a relatively small nucleus of the femur head with good body structure and normal calcium content. This nuclear mass is surrounded by a crescent-shaped area deficient in calcium, which toward the joint showed a transition to a similar crescent-shaped ring with normal calcium content. This process was the same on both sides, and in new roentgenograms, half a year later, showed no change."

Sgalitzer, M. Roentgen diagnosis of renal calculi. *Archiv. f. klin. Chir.*, 1921, cxvi, 231.

The article is based on clinical material of the Eiselsberg Clinic. The ventrodorsal roentgen-ray examination if used alone is insufficient for the demonstration of kidney calculi, except in the typical cases in which the stone represents the effusion of the kidney pelvis and calyx, since there is a possibility of confusion with opaque formations of other organs. For proper orientation, also, lateral roentgenograms are necessary. In a directly lateral roentgenogram, concretions in a normally situated kidney are concealed by the anterior part of the body of the twelfth dorsal or the first to second lumbar vertebrae, or even by the upper part of the third lumbar vertebra. In a frontal roentgenogram, renal calculi which project over on the normal kidney shadow in the ventrodorsal roentgenogram are clearly distinguished from other opaque shadows. Calculi in a ptosed kidney which does not return to its normal position with the patient lying down, are projected in a frontal roentgenogram directly in front of the ventral surface of the last lumbar vertebra. The simultaneous absence of the kidney shadow and the demonstration of kidney stone close to the lowest lumbar vertebra in the ventrodorsal roentgenogram, and of the stone directly in front of the anterior surface of the same vertebra in the frontal roentgenogram, indicate the presence of horse-shoe kidney with stone. The use of the two plates in the diagnosis of renal stone gives very definite information in regard to the number, position and shape of the calculi. The ureter filled with a contrast material can be demonstrated along its entire length in the direct frontal as well as in the oblique roentgenogram, and this makes it possible to visualize all the anomalies in its course, which is important not only in diagnosis but also as a guide to surgical treatment. Ureteral stone situated in the part of the ureter above the pelvic bones can be demonstrated in a lateral roentgenogram.

Haupt and Pinoff. The value of long-distance irradiation in deep therapy. *Deutsche med. Wchnschr.*, 1921, No. 15.

The deep dosage is not improved by an increased distance between focus and skin, or by a large tube. Physical and physiological (chemical-biological) problems are here involved together.

Falta and **Högler**. Radium therapy as a treatment method in internal medicine. *Strahlentherapie*, xii, 217.

Rather remarkable results in erythrocythemia after radiation of the spleen and the bones are described. The radiation areas are divided into fields. The small tubes are allowed to remain on the individual fields from two to eighteen hours. Lymphogranulations and lymphosarcoma, as well as tuberculous lymphomas were greatly benefited. A bone sarcoma at the occiput was made to disappear entirely (histological examination); bursitis subsided, the pains were relieved; one case of trigeminal neuralgia was freed from pains. Of 9 cases of peritoneal tuberculosis, radiated with radium, 6 purely serous cases healed smoothly; the nodular forms failed to react. Investigations on the action of radium in exophthalmic goiter are not yet concluded. In one case, the circumference of the neck diminished 6 cm. within three weeks, the pulse diminishing from 130 to 140 to 80 to 90. The domain of indications for radium treatment cannot yet be outlined. The question arises: Can cases refractory to the *x*-rays, or those cases which have become refractory through frequent *x*-ray radiation, be influenced by radium? It seems noteworthy that the phenomena of "after sickness" (the so-called "Roentgen-Kater" of the Germans) practically never occurred under radium treatment.

David, O., and **Hirsch, Arnold**. Experimental studies on the adrenalin content of the suprarenals following roentgen irradiation. *Klin.-therap. Wchnschr.*, April 23, 1923, p. 790.

Many authors claim that it is possible to exert an inhibitory or stimulative action on the growth and formation of vegetable as well as animal cells, by means of roentgen radiation. It is of special interest to observe such effects of radiation upon the internally secreting glands. The suprarenals here rank among the first objects of experimentation, being especially suitable for this inquiry. The results of the experiments are divided principally into four groups: The first group of observers noted roentgen lesions of the suprarenal parenchyma; the second group believed they saw a distinct lowering of the blood picture after radiation of the suprarenals in hypertonic conditions; the third group was unable in variable observations to establish an arbitrary and absolutely reliable influence upon the blood pressure; whereas the fourth group found the sugar metabolism to be modified through radiation of the suprarenals. The literature accordingly, furnishes no unanimous views as to the possibility of roentgen stimulation of the suprarenals. This is explained by the fact that different results were invariably obtained with different doses, especially as there was no reliable index for estimating the suprarenal function, the blood pressure which is utilized as an index by numerous writers being absolutely useless as such. In the absence of a reaction, the investigators presumably did not reach the suprarenals with the rays, or only in part, while in changes of the sugar metabolism, side-effects upon the pancreas may have intervened.

One of the authors (David) has previously pointed out that on radiation of the isolated suprarenal body, a reliable index is supplied in the first place by the adrenalin contents of the radiated organ, while the other organ, in the second place, constituted a useful method of comparison, provided laboratory animals are selected which have physiologically the same adrenalin contents in both suprarenal bodies. In the performance of accurate experiments, the following four points must be steadily kept in mind:

1. The physiological adrenalin contents of the suprarenals of the examined animals species must be accurately known.
2. The ray-cone must strike the gland separately, so that side-effects upon other organs are excluded.
3. Exact measurements of the administered *x*-ray doses must be practicable.
4. It must be possible to express the results of the radiation in exact terms.

The normal adrenalin contents of the laboratory animals—rabbits, guinea-pigs, dogs—are known through the experiments of Batelli and Ornstein, whose results may still be regarded as correct, in spite of the antiquated procedure. The second condition is met by the operative exposure of one suprarenal body in the animal, and the third condition is met by exposing the administered amount of rays in skin erythema doses (SKE). In order to comply with the fourth request for exact values, preliminary experiments must be performed, ascertaining if the experimental procedure as such, without radiation, acts in any way upon the adrenal system, in the sense of a functional change. It was found that this is not the case, and the preserved suprarenal body never presented a change deviating from the normal standard, as a result of the intervention. For the quantitative determination of the adrenalin contents, Folin's procedure modified by Quantmeyer and Autenrieth was selected. The conditions for the radiations were always identical. Altogether, 40 laboratory animals were radiated, including the preliminary experiments. The doses were 100, 75, 50 and 25 per cent of the skin erythema doses, applied through filters of ½ mm. zinc, 3, 2, and 1 mm. aluminum. The time between radiations and killing of the animals amounted to eight days in the majority of cases. In the following table, prepared from four tables of the principal experiments, the accomplished efforts are compiled, expressed in percentages:

Dose	Number of Experiments	Unchanged	Adrenalin Production	
			Diminished	Increased
1 SKE	7	..	86 per cent	14 per cent
¾ SKE	6	..	50 per cent	50 per cent
½ SKE	8	..	50 per cent	50 per cent
¼ SKE	11	..	....	100 per cent

The findings serve to show the following:

1. The adrenal system is amenable to influences by the *x*-rays.

2. A distinctly weakened function is obtained through radiation with one skin erythema dose.

3. A functional increase is obtained through radiation with ¼ skin erythema dose.

Lichtenberg, A. Visualization of ureteral fistula by the *x*-rays. *Ztschr. f. Urol. Chir.*, vii, Hft. 1–3.

For the accurate determination of the site of a ureteral fistula, an *x*-ray catheter with division into centimeters is inserted into the corresponding (empty) ureter, and a thin, flexible, well-greased shadow-producing sound is introduced by way of the fistula. The last-named procedure is often tedious and difficult. By means of a roentgenogram, the place at which the two catheters come in contact is brought into view. Through subtraction of the portion of the ureteral catheter projecting beyond the intersection from the length of the inserted ureteral sound, the distance of the fistulous orifice from the vesical opening of the ureter is obtained.

Anschütz and Hellmann. The value of post-operative irradiation following radical surgery on mammary carcinoma. *München. med. Wchnschr.*, 1921, p. 1005.

The authors compare this material with the publications of the Tubingen, Marburg, Breslau and Leipsic clinics. In order to obtain a still more accurate differentiation as to the gravity of the cases, the second group of Steintal is divided by them into three subdivisions: Carcinoma, not adherent, glands palpable or found at operation; carcinoma adherent to the skin or the pectoralis muscle, glands positive; carcinoma adherent to the skin and the pectoralis muscle, glands positive. The third group yields bad results. The results in the Kiel clinic were better after radiation following the operation than without after-radiation. The outcome is referred by the authors to their radiation-technique, by means of which they obtained at a depth of 1 cm. 60 to 65 per cent of the carcinoma dose, and at a depth of 2 to 3 cm., 30 to 40 per cent of the carcinoma dose. The intrinsically insufficient effect of these relatively small doses is evidently compensated and rendered perfect, because these doses are applied often, at regular intervals (every four weeks) and the radiation was extended beyond one year. The authors accordingly worked with so-called "drawn out" doses, with a successful outcome in the post-operative therapy of mammary carcinoma. According to their experiences, the authors feel justified in seeing the secret of success in the correct employment of the dosage.

Schütze. Roentgen investigation of the duodenum. *Berl. klin. Wchnschr.*, 1921, No. 33.

The author shows that the duodenum is freely accessible to examination by the *x*-rays, provided fluoroscopy is sufficiently prolonged, up to ten minutes or longer. A great variety of changes are met with, for example, loop formations of partly semicircular, partly circular type. Changes in the position of the duodenum often supply the cause of manifestation which led to the diagnosis of "nervous stomach."

Hütten. Adhesions following thyroid irradiation. *München. med. Wchnschr.*, 1921, p. 983.

In consequence of the uniform findings in his experiments, the author assumes a positive connection between the radiation of goiters and the formation of adhesions, and he, therefore, rejects radiations until practicable conditions are provided under which these adhesions do not occur. In his microscopic investigations he was unable to discover any specific influence of the *x*-rays upon the goiter tissue.

Fraenkel, Manfred. The influence of scattered radiation on glands of internal secretion. *Deutsche med. Wchnschr.*, 1921, No. 9.

Cases of remarkably prompt, hardly-ever-previously-observed, favorable modification of sarcoma, carcinoma, and metastases, have been described by Lenk. The author (Fraenkel) believes that the effect was not due to the scattered radiation, but to an endocrinic glandular action. Stimulating rays produce increased amounts of secretion in these glands, these secretions existing as a growth-inhibitory influence upon the precarcinomatous cells. In fully developed cellular degeneration, rapid destruction and absorption are induced, whereas even the maximum doses of the hardest rays are only capable of inhibiting development. The objective is not a direct, cancer-destroying effect, but a reinforcement of the defensive mechanisms. This new radiation treatment of cancer offers the following advantages: The long sessions of several hours' duration are avoided; the neighboring tissue, whose intactness is very necessary, is not injured; and the cancer cachexia is not increased.

Schinz. The advantage of the roentgen examination in lung tuberculosis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, Hft. 5.

The author makes detailed statements as to the methods of examination, emphasizing especially the possibility of erroneous results in examination of the pulmonary apex and hilus. He very properly states that the modern examination of the lungs included a roentgen examination, but that the roentgen method involves certain sources of error, against which it is necessary to guard. It goes without saying that the roentgen examination can never substitute, but only supplement, the clinical examination.

Marsch, Erich. Coincidence of tuberculosis and sarcoma. *Zentralbl. f. Chir.*, July 22, 1922, p. 1057.

Whereas the simultaneous appearance of tuberculosis and carcinoma has been repeatedly observed, the coincidence of tuberculosis and sarcoma has not, to the author's knowledge, been reported in the literature. Two such cases recently came under his observation, concerning boys, twelve and seventeen years of age respectively. The two cases corresponded in that after five and seven years, respectively, subsequent to the onset of bone and joint tuberculosis, an osteosarcoma and an enchondroma developed as sequelae of the healing tuberculous affection. Both of these patients had been treated for several years with roentgen rays. In the first case, an old tuberculous focus could still be demonstrated, while in the second case, although tubercles were no longer demonstrable, the diagnosis of fungus was undoubted. A purely accidental coincidence cannot be accepted as probable, but judging from the active course, the tuberculosis may be assumed to have acted as a predisposing factor, thus creating a place of lessened resistance for the development of the malignant neoplasm. In the absence of reasons for this unusual simultaneous appearance of the two diseases, the preliminary treatment with roentgen rays must be taken into consideration as an etiological factor for the sarcoma. It is possible that the malignant neoplasm developed as a result of the very frequent radiations to which the tuberculous knee-joints of these two patients were exposed; a sarcoma developing instead of a carcinoma, in conformity with their youthful age.

Meyer, P. S. Effect of *x*-rays on bacillus prodigiosis. *Klin.-therap. Wchnschr.*, Feb. 12, 1923, p. 297.

Summary: (1) A culture of Bacillus prodigiosus, after having once been treated with *x*-rays and damaged in its growth, will grow again in an entirely normal manner, but on repeated radiation, is less seriously damaged than culture which has not been previously radiated. (2) On continued radiation of this prodigiosus strain, the resistance becomes progressively more pronounced; it subsides when the strain is allowed to grow for four weeks without radiation, but at once reappears with the second repeated radiation. (3) This resistance corresponds to the immunity of bacteria against medicinal agents, and like this, may be interpreted as a transformation (Reichenbach). (4) The resistance is specific towards *x*-rays in that it does not exist towards ultraviolet rays.

Hofmann, Artur Heinrich. Compression of the stomach from high-lying colon. *München. med. Wchnschr.*, Feb. 2, 1923, p. 149.

This observation concerned a man of thirty years, who, in getting down from a farm wagon, caught his foot and fell on his hands, head downwards. He had to remain a few minutes in this inverted position before he could free himself. Two hours later, severe abdominal pain supervened, and after a few days, he was admitted to the hospital under the diagnosis of gastric ulcer. The patient (who had always been well before the accident) could take only fluid food, everything else being vomited. Examination showed a bulging gastric fossa; the pyloric region was very tender to pressure. The roentgenogram showed a stomach looking as if cut off at the pyloric antrum. The paste was slightly less opaque in the middle of the lesser curvature, and a slight bulging was also somewhat suggestive of ulcer. The picture was the same at the end of six hours. At the operation, the transverse colon was found to be displaced upwards, and the ligamentum teres was tensely stretched, forming a prominent tendon which constricted the transverse colon and stomach. The stomach was voluminous, and no gastric ulcer was demonstrable. The abdominal coverings were closed after the colon had been replaced in its normal position, and the patient was discharged cured three weeks later. The case was one of displaced transverse colon, which in its turn had caused a compression of the stomach and was itself compressed by the ligamentum teres.

Laroche, G., Brodin, P., and Ronneaux, G. Critical study of chronic appendicitis: Importance of *x*-ray examination. *Presse méd.*, Apr. 8, 1922, p. 28.

The many types of chronic appendicitis make an exact diagnosis difficult. General symptoms and functional disturbances are not sufficiently characteristic to form the basis of a diagnosis. Defensive abdominal tension and the existence of a point constantly sensitive to pressure are of more definite significance; but the latter is difficult to demonstrate, because the location of the appendix is not always the same in different individuals. Of greater importance are the roentgenological findings; repeated examinations made with the patient in different positions will show a point sensitive to pressure at or very near the base of the appendix, that shifts in position with the appendix. For the examination, the cecum must be filled with contrast mixture (barium). Palpation is best carried out with the hand, which must, however, be protected from the prolonged radiation.

Hochstetter. Duodenal stenosis following tuberculous peritonitis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxix, Hft. 2.

A fifty-four-year-old man sent to the hospital with a diagnosis of gall-stones complained of attacks of colicky pains in the abdomen, especially at night, also of pains above the umbilicus after taking food, which were more severe when he was lying down than when sitting, also eructations, diarrhea and vomiting.

The roentgen examination showed the stomach drawn to the right, lying obliquely; no peristalsis, the stomach remaining filled and sausage-shaped after several hours. Foul-smelling contents were withdrawn by gastric lavage; operation showed an extreme stenosis of the ileum caused by a narrow cord-like band of connective tissue; also adhesions to the peritoneum. The patient died soon after operation.

Opitz, Erich. The problem of roentgen and radium dosage. *Klin.-therap. Wchnschr.*, Feb. 5, 1923, p. 243.

The author emphasizes, on the basis of a number of facts, that there exists no *x*-ray dosage through which carcinomatous tissue can be destroyed in every case, and this remark applies with even greater force to the so-called sarcoma dosage. The greatest difficulty for accurate dosage is referable to the general action of the rays. A part of the action of the rays is due not to a direct damage of the cancer cells, but to the general reaction of the body. The measuring of the *x*-ray doses is not only an arithmetical problem which has to discover the time plus the intensity of application. When the radiation, acting in a unit of time, drops below a certain low value (as easily occurs in actual practice) all possibility of success ceases, no matter how long the radiation be continued. Other difficulties arise in estimating the dosage of radium rays, and here again, the essential point is not merely the dose applied to a given carcinoma, but the amount of radium rays absorbed by the body as a whole. Aside from the quantity of radium or mesothorium employed, the position of the preparation and the absorption in the filter are of importance. In these chiefly gynecological applications the entire alpha radiation, and by far the greater part of the beta radiation are destroyed by the filters and thus do not exert an action in the body. It is of great significance for the general action, which portion of the gamma radiation comes to act upon the body, and this depends not only upon the filter material but also upon the thickness of the filter.

Pauchet, Victor. Diverticula of the colon. *Gaz. d. hôp.*, 1922, xcv, No. 41.

Diverticula of the colon are hernia of the mucosa, often resulting from constipation; they are well demonstrated by the roentgen ray after bismuth enema. They are often filled with feces and may cause pelvic abscesses, peritonitis, contractions or ' inflammatory tumors. So long as there are no symptoms due to the diverticula, it is sufficient to treat the constipation. Abscess formation is an indication for drainage; fistulae for resection of the portion of the intestine involved. Inflammatory tumors must be treated like carcinoma, with the difference that the artificial anus need not be made permanent.

Feissly and Fried. Etiology of the "cascade stomach." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxix, Hft. 2.

Description of a case with operation. The operative findings were as follows: The omentum majus was adherent to the anterior abdominal wall; this was detached. The stomach was free, showing no constriction, no sac formation, no scar, neither active nor latent ulcer, no tumor. The posterior gastric wall was far removed from the colon. Pylorus patent, no duodenal ulcer. Pancreas and perigastric region normal. The liver extended slightly above the costal arch. The gall-bladder was small; no concretions in the biliary passages. The gall-bladder was enclosed in a tough membrane full of small blood-vessels; this membrane was detached. A short mesocolon and a very short ligamentum hepatogastricum were found. It is possible that the bilocular shape of the stomach was due to the shortness of this ligament, and also to the adhesions around the gall-bladder. Closure of the wound, which healed normally. Later the patient showed the same symptoms as previous to operation. At the second operation, the findings were as follows: The epiploon was closely adherent to the anterior abdominal wall, the liver and surrounding organs. The colon with the ligamentum gastrocolicum was drawn upwards and the stomach therefore held in an abnormally high position by this ligament. The pars pylorica of the stomach was indented by the abnormal insertion of the ligament. The adhesions were freed with difficulty. The stomach showed nothing abnormal; spleen and kidneys normal. The operation consisted in freeing adhesions and releasing the colon and the liver.

A month after the operation, the roentgen examination again showed the typical cascade stomach. It appears that the cascade stomach was caused by the pull of the transverse colon. The short ligamentum hepatogastricum found at operation may have drawn the stomach too far upwards while the short mesocolon and the pressure of the transverse colon cooperated in producing the result. And since the patient had very probably suffered from some inflammatory condition previously, this was also a factor in the high fixation of the colon. After the operation, the extensive adhesions reformed, which caused an accentuation of the cascade form, and the development of a true cascade stomach.

In classifying the various types of this form of stomach, distinction should be made, first, between the true and the false cascade stomach. The latter includes those types caused by spasm, air in the colon, which are variable and usually respond to treatment with belladonna and atropin, as Carman has described. The true cascade stomach is characterized by the permanence of its form, and can be caused by (*a*) pathological conditions in the stomach (ulcer, scars); (*b*) pathological conditions in the perigastric region (perigastritis, peritonitis, extraventricular tumors); (*c*) changes in the normal course of the colon.

Naturally in certain individual cases spasm may be caused by an ulcer.

KAREWSKI, F. Intussusception of the descending colon. *Deutsche. med. Wchnschr.*, 1921, No. 34, p. 990.

A case report of an intussusception of the large intestine, 25 cm. long, caused by an adenomatous carcinoma of the intestinal wall, of the size of a mandarin, and with a wide base. On the basis of the roentgenological appearance, the author came to the conclusion that an unusually low location of the flexura linealis, most probably due to a general invagination of the descending colon, together with a palpable mobile tumor, indicated a still patent invagination.

ZEHBE. Duodenojejunal diverticula. I. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 2.

The five diagnostic criteria of duodenojejunal diverticulum described by Forsell were all fulfilled in the case reported by Zehbe in a thirty-five-year-old man. For two years there were indefinite pains in the upper and middle abdomen, radiating sometimes toward the liver, sometimes toward the sacral region, often disturbing the night's sleep. These attacks of pain lasted for weeks and months and then would entirely disappear for a time; no vomiting, no heartburn, occasional constipation. Alexander Adams operation without result. Roentgenogram of the stomach showed nothing unusual. The canalis egestorius showed a somewhat rapid peristalsis, which caused the rapid passage of the gastric contents into the duodenum through the pylorus, which was almost constantly open. The duodenal bulb was small, contracted rapidly and strongly, and discharged its contents into a space the size of a goose-egg, which filled rapidly and was situated with its lower pole between the duodenal bulb, the pars pylorica and the stomach. This space, as demonstrated by repeated roentgenological examination, was divided into several sections by folds in the wall and lay eccentric to the duodenum. Its lower pole retained the contrast meal, its upper pole an air vesicle; between these was an intermediary layer. No definite diagnosis was made. Operation showed normal stomach with a few adhesions at the pylorus. Palpation of the duodenum did not give the slightest indication of a diverticulum. The operation did not relieve the symptoms and the roentgen-ray findings were the same after operation as before.

KOHL, F. New treatment lamps for constitutional heliotherapy. *Strahlentherapie*, xii, 994.

Description of two new types of lamps: "Efka" lamp and "Efkaheliol" lamp. The former is a carbon arc lamp with an open burner, in which so-called "effect carbon" is utilized for the production of light, as rich as possible in ultraviolet rays. Four successive light arcs are provided for, and the author adds that the lamps are equipped with an appliance for the removal of injurious vapors. The "heliol" lamp is based upon an altogether different principle; it is a carbon light arc enclosed in a space poor in oxygen. With this adjustment, it is possible to increase the tension. The carbon consumption is much less considerable. Instead of carbon dioxide, only carbon oxide is formed, which provides a better conductivity for the electric current. By means of this increased tension, a light very rich in ultraviolet rays is obtained. By selecting quartz or different kinds of glass for the enclosure of the source of light, it is possible to keep in stock burners with an entirely different spectrum, for different purposes. The lamp can be ordered from Fritz Kohl, 55 Bruderstr., Leipzic.

EISLER. A rare case of Paget's disease. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxix, No. 3.

Multiple joint affections are not infrequently observed in syphilis; the affection of a single joint may likewise occur, and often remains unrecognized as such. Surgical interventions in these misinterpreted cases are injurious. Monoarticular joint disease may be due to congenital as well as acquired syphilis; in the secondary stage, its recognition is not difficult in acquired syphilis, whereas the diagnosis is extremely difficult in the tertiary stage, where in the absence of other syphilitic manifestations, confusions may occur with sporotrichosis, sarcoma, and especially with tuberculosis. The chief differential features with respect to tuberculosis may be summarized as follows: In tuberculosis, weakness of the body, pain on movement, fistulas, cutaneous venous plexus, enlarged glands; relief through rest and fixation. In syphilis, slight tenderness, a strong body, no fistulas, no relief through fixation; a positive Wassermann reaction, and curative effect of antisyphilitic treatment. In monoarticular arthritis, the process may originate from the cartilage as well as from the joint capsule. Eleven cases, observed by the author, are described; 4 of these cases concerned the shoulder joint, 2 the elbow joint, 1 the wrist, 3 the knee and 1 the ankle joint. As shown by accompanying roentgenograms the articular ends were eroded in many cases.

SAUER, H. Osteitis fibrosa. *Deutsche. Ztschr. f. Chir.*, Apr., 1922, clii, 95.

Only those cases of generalized fibrous osteitis which have been investigated clinically, roentgenologically and histologically, and which finally come to autopsy, can furnish information as to the pathogenesis of the disease. The author contributes such a case from the Ringel Department of the St. George Hospital in Hamburg. The patient finally died as a result of complications, after a course of seven years, with periodical arrests and aggravations. The disease appeared in a boy of sixteen years, free from all signs of rickets, as a result of a fall into ice-cold water. Observations during four years again showed that the apparently highly variegated pictures are merely varieties of the same pathological process and represent only stages in the constantly changing picture of the disease. The nature of the process consists in a complete transformation of the bone tissue and substitution of the bone marrow by fibrous tissue in part, with productions of tumor-like structures, which histologically appear either as pure fibromas or as giant-cell sarcomas. Smooth-walled cysts surrounded by solid spongy tissue are the terminal stage of the entire disease, representing a sort of cure. The course of Sauer's case showed a remarkable improvement in the upper limbs, whereas the condition of the lower limbs had rather become aggravated. The fatal outcome was due to a complication in the form of angular kinking of the vertebral column at the transition of the thoracic segment with the lumbar segment, with pressure upon the spinal cord.

The autopsy showed a tumor of the left inferior parathyroid gland, which is referred to by the author as responsible for the pathogenesis of the osteitis fibrosa. Brief clinical histories are given of 11 cases of localized osteitis fibrosa, part of the tumor-forming type, part manifesting themselves as bone cysts. Localization in the ischium was observed in two instances. The prognosis of the localized tumor-forming type is relatively favorable. In the course of years, a sort of spontaneous cure is possible without any therapeutic intervention. The healing process can be accelerated through exposure of the bone focus. This intervention is at first followed by an enlargement of the focus, as after a fracture of diseased bone. The giant cell containing tissue is gradually replaced by newly developed spongy tissue. The bone cysts were all observed on the occasion of a spontaneous fracture. In view of the fact that cases which have not been operated upon have a greater tendency to repeated fractures than the excochleated cases, the treatment should always consist in operative exposure and scraping the cavity. Eleven of the twelve cases concerned the female sex. The age varied between nine and fourteen years.

BAENSCH AND BOEMINGHAUS. *X*-ray differentiation of diseases of the uropoietic system. *Ztschr. f. urol. Chir.*, 1921, vii.

The writer discusses fully the roentgen diagnosis of the uropoietic system and describes the methods used at the Voelcker Clinic. Every roentgenological examination of the kidneys is begun with a bilateral plate (compression diaphragm) in order to avoid errors from contrast materials that persist in situ. Inflation of the abdomen with gas is much used; Goetz technique; introduction of needle through the rectus muscle, insufflation of oxygen. Weak tubes. Before the screen the patient is turned slowly from the dorsal position to the right side, thus lifting the left kidney slowly about 40° out of the deep shadow complex of the back musculature, spinal column and intestines. On the right side conditions are more unfavorable, as here the liver covers the upper pole of the kidney almost completely. Good plates are obtained with the patient in the dorsal position. After the examination, the oxygen is with drawn through a trocar. Serious reactions were never observed. The pyelogram is a valuable aid in roentgenological diagnosis. Only moderately large ureteral catheters should be used so that the collargol can flow back into the bladder on both sides. Injection must be made slowly. The renal pelvis should first be emptied of all residual urine, as otherwise the plates may not be clear owing to great dilution of the collargol. Very clear plates may also be made by the simultaneous inflation of the ureter and the abdominal cavity with air. This method has given excellent results in diagnosis. Unilateral kidney aplasia, horseshoe kidney, and floating kidney can be definitely diagnosed. From the plates conclusions can be drawn as to the isolated and combined enlargement of individual parts of the kidney pelvis and calyx. Mechanical obstructions to urinary flow cause primary dilatation of the so-called anatomical kidney pelvis, while with primary infection, the pelvis at first remains intact, and the capacity of the fornices enlarged partly through dilation, partly through suppurative fusion. Primary dilatation can also be combined with infection (acute and chronic dilatation pyonephrosis). In acute cases ureteral catheterization is contraindicated, as injury to the mucous membrane from the catheter may result in contamination of the blood stream. Kidney tuberculosis is a difficult field, as the process is usually far advanced before it presents a definite roentgenogram. The pathological changes affect chiefly the fornices and calices of the second order. Pneumoperitoneum and air inflation are especially valuable in the diagnosis of kidney stones and of tumor. The ureter is clearly shown in the roentgenological picture; the ureteral catheter can be introduced into the ureteral orifice a few centimeters and then contrast material allowed to flow in. If a contrast catheter is used this stretches the ureter, and pathological kinks are not visible. In insufficiency of the ureteral orifice, excellent plates are obtained if the bladder is filled with collargol, and the patient asked to attempt to urinate, but holding the urethra together. Further, the changes in the bladder during normal micturition, prolapse, pregnancy, hernia, diverticula and hypertrophied prostate are described; also the roentgenological technique for the diagnosis of bladder calculi. The radiological study of the prostate is of only slight value, and methods of making roentgenograms of the seminal vesicles have not been made clinically useful. The same is true of the urethra.

HENSZELMANN. The diagnostic value of colon inflation in the diagnosis of spleen, liver and gall-bladder disease. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxix, No. 4.

The author describes the technique for inflation of the colon with an ordinary type of bellows; this was done at first with the patient upright; later, lying on the left side, as in this latter position the inflation is more uniform and the procedure is better borne. Two hundred to 400 c.c. of air should be introduced four to five times. The intestines should be emptied previously. The outlines of the liver and spleen are very clearly demonstrated; also the pancreas becomes visible. The air can be introduced while the intestine is filled with contrast material. The author presents several illustrations showing his results, for example, a gall-bladder filled with stones, tumors of the spleen and liver, etc.

VOGT. Gastrointestinal examination of the newborn. *Fortsch. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 4.

"Citobarium" is not injurious even for newborn infants who do not refuse to take it. The dose is from 20 to 30 gm. in a thin fluid drinkable infusion. For an enema, a mixture of 20 to 40 gms. with water is used. The usual shape is the angle-hook form, more nearly syphone form. The gastric air bubble is largest immediately after the meal. The stomach is divided into the cardiac portion, the fundus and the pyloric portion. The empty stomach is tubular. The body axis and the stomach axis form an acute angle with each other. The medium time of evacuation of the stomach amounts to one and a half to three hours with mother's milk, somewhat longer with cow's milk. The ileum opens rectangularly into the cecum. The last coil of the ileum descends only as far as the pelvis. The small intestine has the most marked peristalsis. In three hours, the ingested material has passed through the small intestine. The transverse colon takes a gibbet-shaped, extended course. The coil of the descending colon is characterized by great fluctuations with respect to its extent, arrangement and position. The contrast mixture remains three to four hours in the large bowel, after which time it is gradually evacuated. The digestion of a meal consisting of mother's milk requires, on an average, from five to eight hours.

Cattaneo. Subacute and chronic monoarthritis as the only manifestation of luetic infection. *Radiologica med.*, ix, No. 4.

Description of a case. The summary follows. Our case is of interest for several reasons: (1) Paget's bone disease, which is known to cause no clinical or subjective symptoms of any kind at the beginning, can first be recognized in the roentgenogram, principally in a diffuse calcium deficiency of the bone; it is not until later on that hypertrophic changes and deformities make their appearance, as a transformation of the bone tissue of characteristic type. (2) A fracture may complete the decalcification of the bone. (3) Although the calcium deficiency is gradually replaced, the typical deformity producing change of the bone now sets in. (4) Furthermore, the case serves to show that fractures of atypical site and appearance should always direct attention to a pathological condition of the bony framework.

Wolff, E. Diagnosis of high lesser curvature ulcers. *Klin.-therap. Wchnschr.*, 1922, No. 3.

The author shows with many illustrations how an ulcer below the cardia on the lesser curvature of the stomach may often be demonstrated if the patient lies on the left side. Excellent roentgenograms add to the text.

Schinz, H. R. The roentgen appearance of stomach ulcers. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1921, xxxiv (supplement).

This excellent report deals with the peptic ulcer cases studied at the Central Roentgen Institute of the cantonal hospitals of Zurich in the last two years (66 cases) and is of special value because the author was present at each operation and could compare the operative with the roentgenological findings. The many resections done by Professor Claimont yielded especially interesting results in duodenal ulcer. The number of ulcers that were correctly diagnosed and localized is astonishingly large; on the basis of his report, the author concludes rightly that every ulcus callosum can be recognized by the roentgenogram. The cases are described in detail under the following classification: 1. Ulcera callosa of the pars cardiaca of the stomach. 2. Ulcera callosa of the pars media of the stomach (*a*) on or near the lesser curvature, (*b*) on lateral surfaces, (*c*) on the greater curvature. 3. Ulcera callosa of the pars prepylorica. 4. Duodenal ulcers. 5. Mucous membrane ulcers.

The author's statements in regard to the clinical picture and the position of the ulcer are especially valuable. He shows that the clinical picture depends upon a variety of constitutional factors and other conditions, but gives no definite evidence for the localization of the ulcer. Late pains may occur in ulcers at a distance from the pylorus. The only means of localizing ulcers is the roentgenological examination, and in the hands of an experienced roentgenologist, it is a sure means. In addition to localizing the site of the ulcer, the roentgen examination also gives information in regard to the nature of the ulcer, and in this way indicates the necessary treatment, in that all stenosing and penetrating ulcers are absolute indications for operation. A definite diagnosis of mucous membrane ulcers is not possible. The value of the roentgenological examination is in demonstrating the presence of an ulcus callosum, since such cases are suitable for medical treatment.

The treatise is very valuable. It gives a number of important suggestions and urges each roentgenologist to develop his own technique for examinations. The work can be recommended to every surgeon.

Hackradt. The position of the patient in relation to treatment with natural sunshine. *Strahlentherapie*, xii, 1015.

Upon the basis of numerous measurements as well as mathematical deductions, the author arrives at the following conclusions: The radiation should be applied in the recumbent position, in order to guard against increased congestion of the lower extremity. From a distance of 40 cm., the intensity of the quartz lamp light diminished in about the square of the distance. For radiation of the entire body with artificial sunlight, a distance equal to half the length of the body should be selected. The body axis and the light tube axis should go parallel. For entire radiations, the work is most economically done with two lamps, having a distance of 70 cm. from each other, and a distance of 50 cm. from the patient. The consumption of electric current is hardly greater than when only one lamp is used.

Groedel, Franz M. Roentgen symptomatology of duodenal ulcer. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, xxxiv, No. 2.

The roentgenological side of the diagnosis of ulcus duodeni is discussed in a brief but illuminating way in this article, which can be recommended to the attention of every surgeon and every physician studying roentgenology. In general, the author states that the roentgenogram of the diseases to be differentiated are remarkably similar. This is probably due to the fact that they all have the same genetic basis, depending upon abnormal function of the vegetative nervous system. On the other hand, the special roentgenogram of ulcus duodeni is sufficiently characteristic, that as a rule the diagnosis can be correctly made with due consideration of the clinical symptoms.

DALIMIER. Pseudo-cancer of the stomach of syphilitic origin. *Gaz. d. hôp.*, 1922, xcv, No. 2.

This article reports a case of syphilis of the stomach which clinically and roentgenologically simulated carcinoma, with cachexia, which was cured in four weeks by specific treatment.

HROMADA, G. Insufficiency of the ileocecal valve. *Arch. f. klin. Chir.*, 1921, xcvii, 784.

Embryological studies and animal experiments show that normally the valvula Bauhini can be closed. The valve is actively closed by contraction of the m. sphincter ileocolicus both toward the ileum and toward the cecum, and passively serves as a valve against regurgitation from the large intestine. In cases of insufficiency of the valve due to adhesions, etc., a corrective operation by the simple technique of Kellogg or Payr relieves this insufficiency. The method of Kellogg consists in infolding the ileum in the colon. Payr suggested that by means of a simple Lembert suture between the cecum and the upper wall of the ileum, the ileum could be lifted and the normal ileocecal curve reestablished, which guarantees the sufficiency of the valve. This operation has been done in the Leipsic Clinic 16 times; twice the insufficiency of the valve was due to enlarged mesenteric glands; in 6 cases to adhesions after previous operations, and in 9, to adhesions after appendicitis. The symptoms of the patients were all the same, chiefly chronic constipation on which the usual methods of treatment had no effect. After relieving the insufficiency of the valve these symptoms were remarkably improved.

BÉCLÈRE, A. *X*-ray treatment of intra-abdominal manifestations of malignant disease of the testicle. *Strahlentherapie*, xii, 1058.

The patient was a man of thirty-five years in whose case a tumor developed as a sequel of retained testicle, and was removed two years ago by operation. The present condition was one of advanced cachexia with an enormous intra-abdominal tumor. Multiple-fields radiation; filter 1 mm. aluminum; one weekly treatment during several months. Complete subsidence of the tumor, and cure persisting five years at the time of the report. One year after the radiation a small *x*-ray ulcer appeared and was checked through transplantation. The histological examination of the tumor, which was found at the first operation, showed a seminal epithelioma, a so-called seminoma, which in conformity with its origin, was enormously sensitive to the action of the *x*-rays.

ZEHBE. Duodenojejunal diverticula. II. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxvii, No. 5.

A somewhat atypical symptom complex with periodical attacks, gastric pain persisting several hours after meals and at night, radiation of the pain from the mid-line to both sides and also to the back, with nausea, eructations, and sometimes vomiting without hematemesis, suggesting duodenal ulcer, could not be correctly diagnosed, but roentgen examinations during the last three years have shown that these symptoms were due to diverticula in the upper intestine. Three types of diverticula are distinguished according to their location: (1) On the pars media of the duodenum near Vater's papilla; roentgenologically these diverticula are shown below the bulbus duodeni; (2) in the terminal portion of the duodenum (pars ascendens d. ramus inferior)—the shadow of such a diverticulum lies medial to the lesser curvature of the stomach, somewhere between the bulbus duodeni and the angulus ventriculi; (3) in the upper loop of the jejunum below the duodenojejunal flexure. The shadow of a diverticulum of this type is seen in the region of the upper half of the stomach, lateral to the lesser curvature. The correct localization of such diverticula is of clinical as well as scientific interest. While the surgical removal of a diverticulum on the pars media is perfectly possible, a diverticulum located on the upper part of the jejunum, i.e., near the flexure, would be extremely difficult. With the low duodenal diverticula, just above the flexure, lying retroperitoneally, operation is contraindicated according to present knowledge.

VOGT, E. Combination of operative and roentgen therapy for genital tuberculosis. *Deutsche med. Wchnschr.*, 1921, No. 11.

The purely conservative treatment of genital tuberculosis in the female is suitable only in very mild cases, or in cases in which neither operation nor roentgen-ray treatment can be employed for some reason. The great advantage of operative treatment is that only in this way can definite knowledge be obtained in regard to the severity and extent of the disease. However, operative treatment has certain disadvantages. In order to prevent recurrences, operation should be followed by prophylactic roentgen-ray treatment. If operation is impossible for any reason, the roentgen-ray treatment alone may be used with good results, and without danger.

Siegel, P. W. Life expectancy of the uterine cancer patient. *Strahlentherapie*, xii, 97.

Following up König's studies, the author presents the results in uterine carcinoma at the Giessen Gynecological Clinic for 1905 to 1915. On the whole, his results correspond fairly well with König's. While König found the average duration of life in inoperable cases of cervix carcinoma to be one and three-fourths years, and in the operated cases one and one-half years, Siegel found the average duration of life in inoperable cases of this type to be two and one-fourth years, and in the operated cases two and three-fourths years. Operation, therefore, in his cases prolonged life half a year on the average. Five years after the beginning of treatment, 24 per cent of the patients operated for cervix cancer and 13 per cent of those with inoperable carcinoma were living. The results in operated cases were somewhat better in cancer of the corpus uteri. The author believes that roentgen-ray treatment of operable uterine carcinoma in large, properly equipped, special institutions is well justified. He advises fewer radical operations in order to reduce the primary mortality, and the substitution of less extensive operative procedures for removal of the growth, followed by intensive roentgen-ray treatment.

Smidt, Hans. Roentgenologic study of the condition of the stomach during gall-stone colic. *Arch. f. klin. Chir.*, 1921, xcvii, 425.

Eight cases of gall-stone were studied roentgenologically in regard to gastric function during an attack. During an acute attack there is a definitely increased tonus of the entire gastric wall. This hypertonia is accompanied by the development of a spastic condition. The excessive irritation connected with an attack of gall-bladder disease is communicated reflexly to the gastrointestinal tract, and produces the irritative condition described. As the attack ceases, the stomach shows evidence of exhaustion. The gastric symptom complex observed during and after acute attacks of biliary colic is to be considered as a reflex neurosis.

Dehn. A hypophyseal tumor: case report. *Fortschr. a. d. Geb. d. Röentgenstrahlen*, xxix, No. 5.

Patient, a male, thirty-five years (descended from healthy parents) presented the appearance of a small child. The *x*-ray examination showed the following findings: All the epiphyseal lines were preserved, the bones of the head resembling those of a child of ten years; but the phalanges and metacarpals were remarkably thick and short. Both hip-joints presented an advanced coxa vara; the femoral neck formed an acute angle with the shaft, the trochanter major was in contact with the anterior superior iliac spine. The epiphyseal lines were preserved also in this locality; the knee-joint was likewise distinctly deformed; the bones (femur, tibia and fibula) showed an unusual loose-meshed bone structure; likewise the bones of the foot. The skull, aside from the well-marked sutures, presented a distinct diminution in the size of the sella turcica, the dorsum of the sella being thickened in such a way as to produce the impression of a solid square bone instead of a bone plate. The posterior and anterior clinoid processes were approximated to each other in such a way as to be nearly in contact. The bones of the facial skull were relatively undeveloped as compared to the brain capsule. The behavior of the sella turcica, as well as the entire condition of the patient, were in striking contrast with acromegaly. This is in entire conformity with the rule: atrophy of the hypophysis in infantilism; hypertrophy of the hypophysis in acromegaly. The patient subsequently died of pneumonia. At the autopsy, the hypophysis was found to be of normal size, but in a state of cystic degeneration, with gelatinous contents. The dorsum sellae was found to be cartilaginous without traces of ossification, so that it could be cut with scissors.

Lesi. Echinococcus cyst of the tibia. *Arch. ital. di chir.*, Oct., 1921.

Echinococcus cysts in bones are very rare, and according to Lejars (1907) about 82 cases had been reported up to 1907. The echinococcus parasite acts in the bone through pressure and through ischemia, resulting in evacuation and necrosis. The echinococcus embryo passes from the intestine through the portal vein and the venous circulation into the right heart, and from here through the lungs into the left heart, whence it is carried to the peripheral arteries of the bones. Traumatism of the bones may favor the lodging of the parasite or may stimulate a quiescent echinococcus cyst in the bone to an increased size and extent. The symptoms consist of mild bone pains, swelling of the bones and spontaneous fractures. As a rule, multilocular cysts are present. From the viewpoint of the differential diagnosis, bone sarcoma and bone tuberculosis enter into consideration. The author reports an illustrative case which came under his observation. The patient, a girl of twenty-five years, suffered a contusion of the left knee by a fall; walking was not impaired later on, but there was persistent slight painfulness, followed some months later by swelling in the region of the knee. A fluctuating locality was incised, with evacuation of a yellowish fluid. No improvement followed and the patient was admitted to the hospital, where a large cavity in the upper tibial epiphysis was demonstrated by roentgenogram. Surgical intervention with removal of numerous echinococcus cysts was followed by a very protracted recovery, with intermittent fever.

Galewsky, E. Roentgen dermatitis vs. salvarsan dermatitis. *Dermat. Wchnschr.*, 1921, No. 31.

The author reports a case in which a circumscribed dermatitis developed after a roentgen-ray examination in the exact area affected by the rays, and following this a salvarsan dermatitis appeared.

Stark. Progress in deep roentgen therapy. *Strahlentherapie*, xii, 1024.

Report of cases treated during the last year. A very large material from all domains was irradiated (surgical tuberculosis, goiters, skin diseases, tumors, gynecological cases). In a general way, good results were obtained in tuberculosis of variable localization. The demand which has been made to administer 100 per cent of the skin unit dose to a tuberculous joint must not be left unchallenged. After such large doses, extremely grave remote lesions may appear in the extremities (chronic indurated cutaneous edema, scar formation, contractures, circulatory disturbances, ulcers). It is true that these remote lesions are not observed in the first year, but eventually only, at the end of one year after the last irradiation. The writer of the abstract in the *Zentralblatt für Chirurgie* (1922, No. 32, p. 1205) urgently cautions against such high doses, on the basis of several years' experience. The author believes, however, that remote *x*-ray lesions which appear later than about six months after the radiation have no real existence as direct sequelae of the radiation; but he admits that there exists a grave alteration of the tissues, produced through the rays, which renders the tissues hypersensitive to mechanical, bacterial and other stimuli. The tissues must be protected against all injuries. The author assumes that the danger is probably past at the end of a year or two, but his experience is too short for the decision of this question. In the opinion of the abstract writer, the report of such brief observations is of no particular value for surgical *x*-ray therapy. In malignant tumors, the permanent results are of essential interest, and in bone and joint tuberculosis, with its protracted process, an observation of cases treated last year hardly permits a verdict as to the value of the method of treatment.

Herrnheiser. Pseudo-diverticulum of the duodenum. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 4.

Description of a case. The patient was a glassblower, forty-eight years of age, who, for thirteen weeks, had suffered from severe gastric disturbances. A resistance, painful on pressure, was found two fingers' width below the costal arch. The roentgenogram showed at the boundary of the upper and lower third of the descending duodenal segment, a mesially situated, rounded, sharply outlined diverticular evagination, about the size of a hazelnut, and extremely tender on pressure. The autopsy showed a secondary carcinoma of the entire pancreas, in the corpus and cauda (tail) in the form of still indistinct nodules, in the caput (head) in the form of diffuse infiltration, extending to the descending portion of the duodenum, with a duodenal diverticulum, the size of a walnut. Secondary carcinoma of both suprarenals, with almost complete destruction of these organs. Histological examination of the diverticular evagination of the duodenum showed the condition to be due to invasion of the tumor into the duodenal wall, evidently with grafting of a peptic ulcer on the tumor. According to the histological findings, the tumor corresponded to bronchial carcinoma and represented a small cellular infiltrating carcinoma.

Summary: (1) A pancreatic carcinoma, with involvement of the duodenum, without production of stenosis, may form a smooth-walled disintegration cavity, as the result of peptic ulceration, so as to simulate closely the picture of a diverticulum in the roentgenogram. (2) As compared to a carcinomatous pseudo-diverticulum of this kind, the demonstration of extensive mobility, and especially a positive Freud symptom, would be decisive in the differential diagnosis. (3) In case of a negative outcome of the symptoms mentioned under (2), all clinical methods should be utilized for a decision in suspected cases, with special differentiation of the organs which enter into consideration as the starting point for pancreatic metastases.

Kurtzahn, H. Roentgen dosage and roentgen burns. *Deutsche. med. Wchnschr.*, 1921, No. 44, p. 1326.

Upon the basis of personal experience, the author objects to the statements made by Liek (*Deutsche med. Wchnschr.*, 1921, No. 34, p. 999) and confronts these statements with the observations made in the Königsberg Surgical University Clinic, as well as with the principles of *x*-ray irradiation based on other findings.

INDEX TO VOLUME X

Abdominal cases, report of three unusual, Carl H. Parker, 605
  Lesions, diagnosis of obscure, by the roentgen gastro-intestinal examination, W. H. Dickson, 540
Abscess, acute mediastinal: report of four cases in children, Orrin S. Cook, 696
  Subdiaphragmatic, Fred M. Hodges, Abstract, 506
  Subphrenic, operation for, J. Sommer, Abstract, 928
ABSTRACTS:
  Adler, Radiation of carcinoma of the uterus, 80
  Åkerlund, Ake, On a device for the diaphragming of the secondary radiation during roentgen diagnosis, 338
  Andresen, Albert F. R., Linitis plastica, 847
  Anschütz and Hellmann, The value of postoperative irradiation following radical surgery on mammary carcinoma, 1011
  Ashhurts, A. P. C., Bromer, S. R. and White, C. Y., Cystic disease of the bones, 851
  Aubourg and De Jong, S. I., A case of perisigmoiditis verified by roentgen-ray study, 851
  Austrian, Charles R. and Baetjer, Frederick H., Some unappreciated findings in the lungs of normal children, 766
  Baensch and Boeminghaus, *X*-ray differentiation of diseases of the uropoietic system, 1015
  Baetjer, Frederick H. and Austrian, Charles R., Some unappreciated findings in the lungs of normal children, 766
  Bagg, Halsey J. and Bailey, Harold, Effects of irradiation on fetal development, 677
  Bailey, Harold and Bagg, Halsey J., Effects of irradiation on fetal development, 677
    And Quimby, Edith, The use of radium in cancer of the female generative organs, 341
  Baldwin, W. M., A study of the combined action of *x*-rays and vital stains upon paramaceia, 852
  Barclay, A. E., The organization and equipment of an *x*-ray department, 847
  Bartram, Gerhard, Localization of the portio vaginalis in gynecological deep therapy, 1002
  Basch, Roentgen irradiation of inflamed sweat glands in the axilla, 85
  Baylor, J. W. and Crowe, S. J., Benign and malignant growths of the nasopharynx and their treatment with radium, 849
  Bayne-Jones S. and Van der Lingen, The bactericidal action of ultraviolet light, 252
  Bearse, Carl, Osteomyelitis of the ilium in children, 588
  Beattie, Robert, Treatment of sub-acute and chronic otitis media with the use of the *x*-ray, 334
  Beck, Radium treatment of hemangioma, 934
  Béclère, A., *X*-ray treatment of intra-abdominal manifestations of malignant disease of the testicle, 1018
  Béclère, M., Existe-ent-ils des fibromyomes de l'utérus réfractaires á la roentgenthéraphie? 339
  Bell, J. Warren, Pelvioradiography after Fabre's method, 332
  Besser, Herman, Actinomycosis of the lungs simulating tuberculosis, 765
  Beuttner, O., Radium treatment of uterine cancer, 765
  Bierman, M. I. and Jones, W. M., A third omentum, 852
  Birch-Hirschfeld, The question of damage to the eyes from roentgen irradiation, 931
  Birkelo, C. C., Bilateral calcification in the Fallopian tubes, 764
ABSTRACTS:
  Bishop, Louis Faugeres, Fluoroscope in the diagnosis of diseases of the heart, 676
  Blaisdell, Sr., Frank E., Fracture of the tibial spine, 931
  Boeminghaus and Baensch, *X*-ray differentiation of diseases of the uropoietic system, 1015
  Borggreves, Roentgen stereoscopy without expensive special apparatus, 82
  Borrien, Ramond F. and Jacquelin, Ch., Gastric spasms, 1004
  Bost, T. C., Calcification of the ovary, 506
  Böttner, Roentgen therapy of polycythemia with special consideration of the question of cure, 84
  Brodin, P., Ronneaux, G. and Laroche, G., Critical study of chronic appendicitis: importance of *x*-ray examination, 1013
  Brogden, James Chester, Actinomycosis of the gastro-intestinal tract, 174
  Bromer, S. R., White, C. Y. and Ashhurts, A. P. C., Cystic disease of the bones, 851
  Brooks, Clark D. and Clinton, Wm. R., Radium treatment in cancer of the cervix, 334
  Bryant, John, Visceral adhesions and bands; normal incidence, 255
    Visceroptosis: normal incidence, 253
  Burrows, Montrose T. and Herrmann, George R., A hitherto undescribed tumor of the base of the aorta, 79
  Buxton, St. J. D., The association of the surgeon and radiologist in bone grafting, 506
  Campbell, Don M., Carter, John M. and Doub, Howard P., Roentgen-ray studies of the naso-lacrymal passageways, 83
  Camp, O de la, Radiation treatment of tuberculosis, 81
  Carr, James G. and Hanford, C. W., Carcinoma of the esophagus with perforation of the aorta: observations on radium therapy, 83
  Carter, John M., Doub, Howard P. and Campbell, Don M., Roentgen-ray studies of the nasolacrymal passageways, 83
  Case, James T., Pericarditis calculosa (report of a new case discovered roentgenologically), 675
    The new roentgenotherapy in gynecology, 335
  Cassidy, Wm. J., Carcinoma of the breast, its combined treatment with surgery, *x*-ray and radium, 334
  Cattaneo, Subacute and chronic monoarthritis as the only manifestation of luetic infection, 1017
  Chappel, Halbert W., The necessity for an immediate and thorough roentgenological study of all injuries to the spine, 415
  Charrier, A. and Riou, Malignant fibrochondroma of the stomach, 848
  Cherry, Thomas H., The uses of radium in gynecology, 250
  Chizzola, Giuliano, Su due casi di lussazione palmare totale dell' osso semilunare, 342
  Christopher, F. and Halstead, A. E., Calcification and ossification of the meninges, 848
  Claremont, H. Ethelberta and McClure, James, Case of inverted pylorus obstructing a gastrojejunostomy aperture, 764
  Coffey, Robert C., Treatment of cancer of the rectum, 341
  Cohn, Isidore, Forward dislocation of both bones of the forearm at the elbow, 411
  Collin, Edward, A study on the roentgen aspect of tuberculosis of the joints and its relation to the clinical aspect, especially when under treatment by universal light baths, 336

ABSTRACTS:
  Cooke, A. B., When appendicitis is not appendicitis: a case of diverticulitis of the cecum, 415
  Cooper, J. R., Fibroma of stomach, 418
  Crowe, S. J. and Baylor, J. W., Benign and malignant growths of the nasopharynx and their treatment with radium, 849
  Daels, Frans, Histological pictures representing the cure of uterine basocellular epithelioma, 413
  Daland, Ernest M., Radium treatment of keloids, 411
  Dalimier, Pseudo-cancer of the stomach of syphilitic origin, 1018
  Dandy, Walter E., Localizing brain tumors in comatose patients, 1000
  David, O. and Hirsch, Arnold, Experimental studies on the adrenalin content of the suprarenals following roentgen irradiation, 1010
  Davis, George G., Osteosclerosis fragilis generalista, 1001
  Dawson, Turner, The use of radium in the treatment of disease, 929
  de Courmelles, Foveau, Radioanaphylaxie, 339
  Dehn, A hypophyseal tumor: case report, 1019
  De Jong, S. I. and Aubourg, A case of perisigmoiditis verified by roentgen-ray study, 851
  Deming, Clyde Leroy, Congenital sarcoma of kidney in a child of twenty-nine days, 587
  Doub, Howard P., Campbell, Don M. and Carter, John M., Roentgen-ray studies of the nasolacrymal passageways, 83
  Drüner, L., The technique of fluoroscopy: description of a new appliance, 1002
  Dunham, Kennon and Skavlem, John H., Sinus disease and lung infections, 335
  Edling, Lars, The results of our treatment of tuberculous lymphadenitis by roentgen rays at Lund from 1908 to 1918, 337
  Eisler, A rare case of Paget's disease, 1015
  Enfield, Charles D., The scope of the roentgenologist's report, 680
  Ernst, N. P., Results of treatment of surgical tuberculosis with carbon arc-light baths, Finsen's Light Institute from 1913 to 1921, 338
  Erskine, Arthur W., *X*-ray treatment of carcinoma of the breast, 257
  Evans, William A., *X*-ray treatment in the diseases of the ear, nose and throat, Abstract, 334
  Faber, Gastroptosis and the shape of the thorax, 849
  Falta and Högler, Radium therapy as a treatment method in internal medicine, 1010
  Fay, Temple and Grant, Francis C., Ventriculoscopy and intraventricular photography in internal hydrocephalus, 680
  Feissly and Fried, Etiology of the "cascade stomach," 1013
  Fisher, E. B., Experiments on the bactericidal action of the violet ray, 849
  Foerster, Clinical and roentgenological observations in cases of duodenal adhesions, 82
  Fontaine, Bryce W., Pulmonary fibrosis, 586
  Fraenkel, Manfred, The influence of scattered radiation on glands of internal secretion, 1011
  Fränkel, Combination of tuberculosis with primary or roentgen carcinoma of the breast, 929
  Fried and Feissly, Etiology of the "cascade stomach," 1013
  Friedlaender, Bernhard, Diagnostic value of artificial pneumoperitoneum in sterility in women, 506
  Gaertner, G., Death after pneumoperitoneum, 679
  Galewsky, E., Roentgen dermatitis vs. salvarsan dermatitis, 1020
  Gardner, Boyd S. and Stokes, J. H., The demonstration of unerupted Hutchinson's teeth by the roentgen ray, 412

ABSTRACTS:
  Glass, Development of *x*-ray plates in bright light (safranine method), 84
  Glover, Donald M., Osteopsathyrosis: report of a case, 1005
  Goosmann, Charles and Schenck, W. E., Melanotic sarcoma of eye, 505
  Granger, Amedée, A new technique for the positive identification of the sphenoid sinus and the ethmoid cells, 678
  Grant, Francis C. and Fay, Temple, Ventriculoscopy and intraventricular photography in internal hydrocephalus, 680
  Graves, Roger Colgate, Shadowless renal calculi, 331
  Green, Nathan W. and LeWald, Leon T., The differential diagnosis between tuberculosis and lung abscess, 1008
  Groedel, Encapsulated pleura as seen roentgenologically, 1003
    New form of orthodiagraph, 932
  Groedel, Franz M., Roentgen symptomatology of duodenal ulcer, 1017
  Groover, Thomas A., The relation of radiology to cancer control, 256
  Grosh, L. C. and Stifel, J. L., Defects in the membranous bones, diabetes insipidus and exophthalmus with report of a case, 332
  Grynfelt, Post-traumatic osteoporosis of the bones of the extremities (improperly called atrophy by the radiologists), 764
  Guisez, J., Radium treatment of cancer of the esophagus, 1000
  Hackradt, The position of the patient in relation to treatment with natural sunshine, 1017
  Haenisch, F., Abstract of proceedings of the fourteenth session of the German Roentgen Ray Society, Munich, April 15–18, 1923, 666
  Halstead, A. E. and Christopher, F., Calcification and ossification of the meninges, 848
  Hammer, Roentgen treatment of scleroderma, 1003
  Hanford, C. W. and Carr, James G., Carcinoma of the esophagus with perforation of the aorta: observations on radium therapy, 83
  Haupt and Pinoff, The value of long-distance irradiation in deep therapy, 1009
  Heckel, Edward B., Non-surgical treatment of malignant epibulbar neoplasms, 255
  Hellmann and Anschütz, The value of postoperative irradiation following radical surgery on mammary carcinoma, 1011
  Henzelmann, The diagnostic value of colon inflation in the diagnosis of spleen, liver and gall-bladder disease, 1016
  Herman, N. B. and Von Glahn, William C., Carcinoma of the supra-ampullary portion of the duodenum, 417
  Herrmann, George R. and Burrows, Montrose T., A hitherto undescribed tumor of the base of the aorta, 79
  Herrnheiser, Pseudo-diverticulum of the duodenum, 1020
  Hess, Alfred F. and Weinstock, Mildred, A study of light waves in their relation to rickets, 589
  Heyman, James, Results of the treatment of climacteric hemorrhages by radium therapy in the Radium Clinic, Stockholm, 338
  Hirsch, Experiences with the Loose filter, 1001
  Hirsch, Arnold and David, O., Experimental studies on the adrenalin content of the suprarenals following roentgen irradiation, 1010
  Hirsch, Henri, Concerning roentgen sickness and roentgen cachexia, 1002

ABSTRACTS:
Hochstetter, Duodenal stenosis following tuberculous peritonitis, 1013
Hochstetter, F., Duodenal stenosis following an ancient tuberculous peritonitis, 415
Hodges, Fred M., Subdiaphragmatic abscess, 506
Hofmann, Artur Heinrich, Compression of the stomach from high-lying colon, 1012
Högler and Falta, Radium therapy as a treatment method in internal medicine, 1010
Hollander, Edward, Fallibility of roentgenologic evidence of healed gastric ulcer, 412
Holzknecht, Dosage in deep roentgen therapy from the biological point of view, 1003
Hromada, G., Insufficiency of the ileocecal valve, 1018
Hudson, B. and Sutton, P. G., *X*-ray examination of the chest, 930
Hütten, Adhesions following thyroid irradiation, 1011
Hütten, V. D., Duration of cure of operated breast carcinoma with and without prophylactic *x*-ray treatment, 500
Hyman, A., Diverticula of the bladder in children, 415
Jacquelin, Ch., Borrien and Ramond, F., Gastric spasms, 1004
Japiot, Contribution to the radiographic study of the causes of lumbar arthritis, 589
Johnson, Fred M. and Quick, Douglas, Cancer of the larynx treated by radium, 83
Jones, W. M. and Bierman, M. I., A third omentum, 852
Joseph, A case of death following pneumoperitoneum, I, 80
  Death after pneumoperitoneum, II, 676
Jüngling, Otto, Roentgen treatment of surgical tuberculosis, 1003
Kaess, F. W., Temporary sterilization of the parotid by *x*-rays in the treatment of salivary fistulae, 1008
Karewski, F., Intussusception of the descending colon, 1014
Karshner, Rolla G., *X*-ray of the heart, 82
Keiffer, The mechanism of retrogression of human uterine fibroids, 415
Kelly, Howard A., Radium therapy, with special reference to diseases of the female pelvis: a rejoinder, 590
Kirkendall, Ben R., Pre-operative and postoperative radium therapy: report of cases, dosage and methods, 174
Kjaergaard, S., Operative versus radiological treatment of fibroids, 764
Kleinberg, S., Periosteal chondrosarcoma, 1000
Knox, R., Treatment by *x*-ray and radium, 1004
Kohl, F., New treatment lamps for constitutional heliotherapy, 1014
Kohler, *X*-ray treatment of pathological fractures, 85
König, Fritz, Operation in an irradiated field, 1003
Kothen, The measure of the percentage depth dose with Kienböch strips after the method of Baumeister, 1001
Knapp, Harry B., Dislocation of the semilunar carpal bone, 418
Krida, Arthur, Secondary os calcis, 589
Kurtzahn, H., Roentgen dosage and roentgen burns, 1020
Laborde, S., Leroux, R., Peyre, Ed and Roussy, G., Concerning regular and general reaction of the organism following radiation treatment of cancer of the cervix uteri, 331
Lahmann, Combined roentgen and sunshine treatment of granuloma, 1009

ABSTRACTS:
Lane, Laura A., A study of the tonsil question with a preliminary report of roentgen-ray and radium therapy in the treatment of pathologic tonsils, 342
Laroche, G., Brodin, P. and Ronneaux, G., Critical study of chronic appendicitis: importance of *x*-ray examination, 1013
Lasch, The effect of artificial high altitude sun on metabolism (Alpine lamp), 86
Laurell, Hugo, A contribution to the roentgenology of genuine mixed tumors of the trunk, 336
Lawrence, R. D., The effect of *x*-rays on enzyme action, 253
Ledoux-Lebard, Le cancer des radiologistes, 340
Lee, Harrie B. and Morton, Reginald, Some results of deep *x*-ray therapy, 257
Lemere, H. B., Progressive osteomyelitis of the frontal bone, 505
Leroux, R., Roussy, G., Laborde, S. and Peyre, Ed., Concerning regular and general reaction of the organism following radiation treatment of cancer of the cervix uteri, 331
Lesi, Echinococcus cyst of the tibia, 1019
Levy-Dorn and Weinstein, The effect of *x*-ray treatment on blood pressure, 929
LeWald, Leon T., The relation of the heart, pericardium and the heart valves to the anterior chest wall, I, 333
  The relation of the heart, pericardium and the heart valves to the anterior chest wall, II, 1007
  And Green, Nathan W., The differential diagnosis between tuberculosis and lung abscess, 1008
Lexer, Treatment of surgical tuberculosis, 85
Lichtenberg, A., Visualization of ureteral fistula by the *x*-rays, 1011
Lilienthal, Howard, Resection of the lung for suppurative infections, 340
Lotsy, A case of left-sided renal stone together with gall-stones in the colon, 1000
MacCarty, William Carpenter, Does cancer arise in chronic gastric ulcer? 174
MacNeal, Ward J. and Willis, George S., A skin cancer following exposure to radium, 505
Marsch, Erich, Coincidence of tuberculosis and sarcoma, 1012
Maximow, A. A., Changes produced by roentgen rays in inflamed connective tissue, I, 851
  Changes produced by roentgen rays in inflamed connective tissue, II, 932
McClure, James and Claremont, H. Ethelberta, Case of inverted pylorus obstructing a gastrojejunostomy aperture, 764
Mengert, Prophylactic irradiation with high altitude sun in rachitis, 80
Meyer, P. S., Effect of *x*-rays on bacillus prodigiosis, 1012
Minet, H., Calcified hydatid cysts of the kidney, 1002
Moffat, Barclay W., Isolated disease of the scaphoid, 411
Moore, Beveridge H., Subastragaloid dislocation of the foot, 411
Moore, C. N., Physical principles underlying the development of high voltage roentgen-ray apparatus, 342
Morton, Reginald and Lee, Harrie B., Some results of deep *x*-ray therapy, 257
Mosenthal, A., Roentgen appearances of pyonephrosis, 931
Nogier, Th., Traitement de l'hypertrophie amygdalienne par les rayons *x*, 340
Nordentoft, S., On the roentgen treatment of brain tumors, 337

Abstracts:
- Nordentoft, Severin, New points in the treatment of uterine cancer with radium, 1008
- Nurnberger, L., *X*-raying of the spleen to control uterine bleeding, 930
- Nuttall, H. C. Wardleworth, Tuberculosis of the sacroiliac joint, 588
- Opitz, Erich, The problem of roentgen and radium dosage, 1013
- Osborne, Sutherland, Scholl and Rowntree, Roentgenography of urinary tract during excretion of sodium iodid, 587
- Pancoast, Henry K., The roentgenologic aspect of chronic appendicitis, 332
  - And Pendergrass, Eugene P., The roentgen-ray treatment of erythremia, 335
- Parrisius, W., Warning against overdosing with *x*-rays in cases of myelomatous leukemia, 592
- Partsch, Fritz, Indications for pneumoperitoneum, 930
- Pauchet, Victor, Diverticula of the colon, 1013
- Pendergrass, Eugene P. and Pancoast, Henry K., The roentgen-ray treatment of erythremia, 335
- Perthes, The biology and radiation therapy of cancer, 921
- Perthes, G., Radiotherapy of malignant tumors, 250
- Petersen, William F. and Saelhof, Clarence C., Roentgen-ray stimulation of the pancreas in experimental pancreatic deficiency, 79
- Peyre, Ed, Roussy, G., Laborde, S. and Leroux, R., Concerning regular and general reaction of the organism following radiation treatment of cancer of the cervix uteri, 331
- Pfahler, George E., The treatment of skin cancer by *x*-rays, radium and electrocoagulation, 254
- Pfahler, George E. and Thomas, B. A., Technique of the treatment of carcinoma of the bladder and prostate by a combination of surgery, electrocoagulation, radium implantation and roentgen rays, 254
- Phemister, D. B., The nature of cranial hyperostosis overlying endothelioma of the meninges, 850
- Pilger, W., Deep *x*-ray therapy: the technique of the Erlangen Clinic, 330
- Pinoff and Haupt, The value of long-distance irradiation in deep therapy, 1009
- Platt, Harry, Pseudo-coxalgia: a clinical and radiographic study, 249
- Polak, John Osborn, Notes on the clinical value of radium in the management of uterine hemorrhage, 675
- Poos, Fritz, Concerning the indirect damaging effects of irradiation on the body through irradiation of isolated organs, 256
- Portmann, U. V., The efficiency of radiation therapy, 1001
- Pryor, J. H., Immobility of the diaphragm, with report of cases of bilateral immobility, 766
- Purcell, C. E., An interesting *x*-ray study of a foreign body: honey locust seed in the right bronchus, 413
- Quick, Douglas and Johnson, Fred M., Cancer of the larynx treated by radium, 83
- Quinby, W. C., Perirenal insufflation of oxygen, 766
- Ramond, F., Jacquelin, Ch. and Borrien, Gastric spasms, 1004
- Rand, Carl W., Osteoma of the skull, 851
- Rauschburg, Two cases of hypophyseal dystrophia adiposogenitalis and their treatment by means of the roentgen rays, 86
- Regaud, Cl., The error of division and too frequent repetition of doses in the radiation treatment of cancer, 255

Abstracts:
- Reichold, Albert, The effect of roentgen rays on the mitotic cells in carcinomatous tissues and on the blood-vessels, 592
- Renaud, Maurice, The administration of morphin to cancer cases, 505
- Reverchon et Worms, Valeur séméiologique de la radiographie dans l'étude de la polysinusite grippale, 851
- Révész, A case of renal calculi mistaken for echinococcus cyst, 931
- Rhormley, R. K., A case of congenital osteosclerosis, 852
- Rhule, R., Roentgenological studies concerning an alteration in the upper wall of the os innominatum known as the os acetabuli, 679
- Riou and Charrier, A., Malignant fibrochondroma of the stomach, 848
- Richardson, Edward P., Relative value of surgery and roentgen rays in the treatment of hyperthyroidism, 585
- Rieder, Irradiation sickness, 1000
- Rieder, Wilhelm and Seitz, Ernst, An apparatus for the exact determination of the central ray in the roentgen treatment of rectal carcinoma, 932
- Roberts, C. S. Lane, Some considerations of the sacroiliac joint, 506
- Roberts, R. E., A case of extreme dilatation of the duodenum due to chronic obstruction, 253
- Ronneaux, G., Laroche, G. and Brodin, P., Critical study of chronic appendicitis: importance of *x*-ray examination, 1013
- Roussy, G., Laborde, S., Leroux, R. and Peyre, Ed., Concerning regular and general reaction of the organism following radiation treatment of cancer of the cervix uteri, 331
- Rowntree, Osborne, Sutherland and Scholl, Roentgenography of urinary tract during excretion of sodium iodid, 587
- Rüppel, Hilum tuberculosis in adults, 81
- Rydgaard, Frode, Vaquez' disease cured by *x*-ray treatment, 1009
- Rzewuski, Osmo regulation of roentgen tubes, 1004
- Saberton, Ante-operative *x*-ray irradiation, 1001
- Saelhof, Clarence C. and Petersen, Wm. F., Roentgen-ray stimulation of the pancreas in experimental pancreatic deficiency, 79
- Saget, M., The intensiometer, 416
- Sante, L. R., Pneumoperitoneum as an aid in the diagnosis of subdiaphragmatic conditions, 418
- Sanvenero, F., Sarcoma successfully treated by *x*-rays, 929
- Sauer, H., Osteitis fibrosa, 1015
- Schaedel, H., Radiation as an aid in the operative treatment of parotid fistula, 1008
- Schall, W. E., A new *x*-ray spectrometer, 927
- Schenck, W. E. and Goosmann, Charles, Melanotic sarcoma of eye, 505
- Schinz, The advantage of the roentgen examination in lung tuberculosis, 1012
- Schinz, H. R., Human castration by the *x*-ray (Ein Beitrag zur Roentgen-Kastration beim Mann), 852
  - The roentgen appearance of stomach ulcers, 1017
- Schmidt, Ernst Albert, Experimental and histological investigations concerning the effect of roentgen rays upon the staining properties of tissue, 1006
- Scholl, Rowntree, Osborne and Sutherland, Roentgenography of urinary tract during excretion of sodium iodid, 587
- Scholz, Thomas, A roentgenological contribution to the diagnosis of spinal carcinoma in cases having an unrecognized primary focus, 254
- Schreus, Studies on static electricity of the roentgen tube, 1001

Abstracts:
Schroeder, J. Henry, Sarcoma (?) of thigh, with secondary sarcoma (?) of inguinal region, liver and lungs: recovery after deep roentgen irradiation, 412
Schütze, Roentgen investigation of the duodenum, 1011
Schwarz, The diminution and increase of radiosensibility of animal tissue and their importance for radiotherapy, 81
Schweitzer, Life expectancy after radioactive treatment of carcinoma of the cervix, 1009
Scott, S. Gilbert, A method for the opaque meal examination of the stomach, 504
Sears, Nathan P., A new method of making ureteropyelograms, 339
Seitz, Ernst and Rieder, Wilhelm, An apparatus for the exact determination of the central ray in the roentgen treatment of rectal carcinoma, 932
Sgalitzer, M., Roentgen diagnosis of renal calculi, 1009
Sgalitzer, Max, The roentgen diagnosis of disease of the esophagus, especially esophageal cancer, 934
Sherk, Henry H., Total transposition of viscera, 252
Siegel, P. W., Life expectancy of the uterine cancer patient, 1019
Simonetti, Contribution to the study of gastric stimulation by *x*-rays, 850
Smidt, Hans, Roentgenologic study of the condition of the stomach during gall-stone colic, 1019
Smith, Morris K., Premature ossification after separation of the lower radical epiphysis, 257
Smithies, Frank, Necessity for caution in the employment of high voltage roentgen rays as a therapeutic agent against malignant disease: acute adrenal insufficiency and death as sequelae, 414
Sommer, J., Operation for subphrenic abscess, 928
Spinelli, M., Contribution to the roentgen and radium treatment of uterine cancer, 1003
Stark, Progress in deep roentgen therapy, 1020
Stein, Roentgen treatment of condylomata acuminata, 80
Stephens, Richmond, Fracture of the spine of the tibia, 587
Stevens, Rollin H., Advances in radiation therapy of deep-seated tumors, 444
Stokes, J. H. and Gardner, Boyd S., The demonstration of unerupted Hutchinson's teeth by the roentgen ray, 412
Stokes, John H. and Brown, Philip W., Two hundred syphilitic patients whose chief complaint was "stomach trouble": an interpretative analysis of the diagnosis of syphilis in consultant medical practice, 249
Strauss, A., The problem of radium and surgery in the treatment of cancer, 339
Summers, John E., Transposition of viscera (situs viscerum transversus). Report of a case without transposition of the usual abdominal reflex, 588
Sutherland, Scholl, Rowntree and Osborne, Roentgenography of urinary tract during excretion of sodium iodid, 587
Sutton, P. G. and Hudson, B., *X*-ray examination of the chest, 930
Symonds, C., Gonorrheal stricture of the rectum, 851
Tanturri, Domenico, Radium therapy of rhinoscleroma, 934
Tarnauceanu, Épreuve de Goetsch et radiotherapie dans les affections du corps thyroide (Goetsch's test and radiotherapy in diseases of the thyroid), 848
Taussig, L. R., The radium treatment of carcinoma of the mouth, 847

Abstracts:
Tees, Frederick J., Anterior dislocation at the elbow-joint, 587
Thedering, *X*-ray stimulation doses and diseases of the hair, 412
Thomas, B. A. and Pfahler, G. E., Technique of the treatment of carcinoma of the bladder and prostate by a combination of surgery, electrocoagulation, radium implantation and roentgen rays, 254
Van der Lingen and Bayne-Jones, S., The bactericidal action of ultraviolet light, 252
Vinson, Porter P., Cardiospasm associated with esophageal diverticula, 850
Vogt, Gastrointestinal examination of the newborn, 1016
Vogt, E., Combination of operative and roentgen therapy for genital tuberculosis, 1018
Von Glahn, William C. and Herman, N. B., Carcinoma of the supra-ampullary portion of the duodenum, 417
Voorhoeve, N., The roentgenologic symptom-complex of horseshoe kidney, 1006
Wachter, The influence of roentgen rays on gastric secretion, 929
Waldenström, H., The definite form of the coxa plana, 336
Webster, J. H., The clinical results of the treatment of malignant disease, 928
Weil, A rare roentgen finding in a child's femur, 1009
Weinstein and Levy-Dorn, The effect of *x*-ray treatment on blood pressure, 929
Weinstock, Mildred and Hess, Alfred F., A study of light waves in their relation to rickets, 589
Weis, Howard A., A contribution to the study of the effects of radium upon rabbit ovaries, 1005
Wels, The diagnosis and mechanism of idiopathic elevation of the diaphragm, 933
Werner, A contribution to our knowledge of the generative processes after radium and roentgen deep therapy, 82
Wesson, M. B., Pyelography: common diagnostic errors, 848
Wetterer, Roentgen treatment of the complications of gonorrhea, 1002
Wetzel, Damage from irradiation treatment with and without changes in the skin, 931
Wheelon, Homer, Duodenal motility, 411
Whitcher, B. R., Blood changes in myelogenous leukemia following radium treatment, 174
White, C. Y., Ashhurts, A. P. C. and Bromer, S. R., Cystic disease of the bones, 851
White, J. Renfrew, A case of multiple pulsating bone tumors, 249
Wille, O., The value of the tube beneath the table in deep roentgen therapy, 1004
Willis, George S. and MacNeal, Ward J., A skin cancer following exposure to radium, 505
Wolff, E., Diagnosis of high lesser curvature ulcers, 1017
Worms et Reverchon, Valeur séméiologique de la radiographie dans l'étude de la polysinusite grippale, 851
Zaaijer, J. H., Cardiospasm in the aged, 587
Zehbe, Duodenojejunal diverticula, I, 1014 and II, 1018
Zumpe, H., Changes in the blood picture and its value in the prognosis of the roentgen therapy of cancer, 930
Adeno-papilloma, report of a case of, of the stomach, I. S. Ingber, 539
Adhesions and bands, visceral: normal incidence, John Bryant, Abstract, 255
Aged, cardiospasm in the, J. H. Zaaijer, Abstract, 587

Aikins, W. H. B., The use of radium in the treatment of the leucemias and Hodgkin's disease, 853
Alexander, William G., Report of a case of so-called "marble bones" with a review of the literature and a translation of an article, 280
Alvarez, Walter C., A note on the use of the Bucky-Potter diaphragm with the fluoroscope, 69
  New light on gastric peristalsis, 31
Anderson, Frank W. and Bowing, Harry H., The treatment by radiation of cancer of the rectum, 230
Andrews, George C. and MacKee, George M., Dermatitis artifacta simulating roentgen dermatitis, 617
Animal tissue, the diminution and increase of radiosensibility of, and their importance for radiotherapy, Schwarz, Abstract, 81
Annular shadows: are they cavities or spontaneous pneumothoraces? Philip King Brown, 445
Ante-operative *x*-ray irradiation, Saberton, Abstract, 1001
Antrum and frontal sinus, the acute infections of, roentgen therapy of, John D. Osmond, 374
Appendicitis, chronic, critical study of: importance of *x*-ray examination, G. Laroche, P. Brodin and G. Ronneaux, Abstract, 1013
  Chronic, the roentgenologic aspect of, Henry K. Pancoast, Abstract, 332
  When, is not appendicitis: A case of diverticulitis of the cecum, A. B. Cooke, Abstract, 415
Arteries, atlas of the, first aid *x*-ray, H. C. Orrin, Book review, 992
Arthritis, chronic deforming, roentgen gastrointestinal studies of patients with, R. G. Taylor, 424
  Lumbar, contribution to the radiographic study of the causes of, Japiot, Abstract, 589
Arthrosis obliterans, sacroiliac, Edward S. Blaine, 189
Association of the surgeon and radiologist in bone grafting, the, St. J. D. Buxton, Abstract, 506

Bacillus prodigiosis, effect of *x*-rays on, P. S. Meyer, Abstract, 1012
Bagg, H. J. and Little, C. C., The occurrence of two heritable types of abnormality among the descendants of *x*-rayed mice, 975
Baths, carbon arc-light, Finsen's Light Institute from 1913 to 1921, results of treatment of surgical tuberculosis with, N. P. Ernst, Abstract, 338
Beeler, Raymond C. and Emerson, Chas. P., An unusual case of double spontaneous pneumothorax, 126
Beers, Nathan T., A radium applicator for small lesions, 643
Bierman, Morris I., The lumbar transverse processes, 456
Biliary ducts and gall-bladder, importance of indirect roentgen findings in chronic infection of the, M. P. Burnham, 105
Biological reactions of *x*-rays: effect of radiation on the nitrogen and salt metabolism, Carl F. Cori and G. W. Pucher, 738
Biology and radiation therapy of cancer, the, Perthes, Abstract, 921
Bissell, Frank S., A comparison of clinical and roentgenological observations in pulmonary tuberculosis, 428
Bladder, diverticula of the, in children, A. Hyman, Abstract, 415
Blaine, Edward S., Sacroiliac arthrosis obliterans, 189
  Standardization of *x*-ray exposure identification, 303
Bloodgood, Joseph Colt, The diagnosis and treatment of bone lesions: a brief summary of the salient features, 42
Blood picture, changes in the, and its value in the prognosis of the roentgen therapy of cancer, H. Zumpe, Abstract, 930
Blood pressure, the effect of *x*-ray treatment on Levy-Dorn and Weinstein, Abstract, 929
Boardman, W. W., Enteroliths, 369
Bone grafting, the association of the surgeon and radiologist in, St. J. D. Buxton, Abstract, 506
  Lesions, periosteal, roentgen-ray study of non-luetic, Roy G. Giles, 593
    The diagnosis and treatment of: a brief summary of the salient features, Joseph Colt Bloodgood, 42
    The, of smallpox with report of cases, Francis B. Sheldon, 35
  Semilunar carpal, dislocation of the, Harry B. Knapp, Abstract, 418
Bones, cystic disease of the, A. P. C. Ashhurts, S. R. Bromer and C. Y. White, Abstract, 851
BOOK REVIEWS:
  Åkerlund, Åke, Roentgenological studies of the duodenal bulb, 310
  Bachem, Albert, Principles of *x*-ray and radium dosage, 992
  Jaches, L. and Wessler, H., Clinical roentgenology of diseases of the chest, 919
  Jackson, Chevalier, Bronchoscopy and esophagoscopy, 258
  Kerley, Charles Gilmore and LeWald, Leon Theodore, Digestive disturbances in infants and children, 845
  LeWald, Leon Theodore and Kerley, Charles Gilmore, Digestive disturbances in infants and children, 845
  Orrin, H. C., First aid *x*-ray atlas of the arteries, 992
  Sampson, C. M., Physiotherapy technic, 992
  Simpson, Frank Edward, Radium therapy, 458
  Voltz, Frederick, The physical and technical foundation for the measurement and dosage of the roentgen rays, 78
  Wessler, H. and Jaches, L., Clinical roentgenology of diseases of the chest, 919
Borzell, F. F. and Tyson, R. M., Preliminary observations of cardiac measurements in children, 559
Bower, J. O. and Clark, J. H., A preliminary report of the action of buried radium on diseased thyroids in man, 875
  The resistance of the thyroid gland to the action of radium rays. The results of experimental implantation of radium needles in the thyroid of dogs, 632
Bowing, Harry H. and Anderson, Frank W., The treatment by radiation of cancer of the rectum, 230
Brain tumors, localization of, by cerebral pneumography, Walter Dandy, 610
  On the roentgen treatment of, S. Nordentoft, Abstract, 337
Bronchitis, fibrinous, F. Hase Rodenbaugh, 843
Bronchoscopy and esophagoscopy, Chevalier Jackson, Book review, 258
Brown, Percy, A relatively large foreign body in the orbit, 842
Brown, Philip King, Annular shadows: are they cavities or spontaneous pneumothoraces? 44
Bucky diaphragm with wide slits, a, W. L. Snider, 604
  Diaphragms, an automatic switch for, Eugene Vernon Powell, 67
Bucky-Potter diaphragm with the fluoroscope, a note on the use of the, Walter C. Alvarez, 69
Bullet, case of, in heart with recovery, F. C. Swearingen, 454
Bundy, Harry E. and Schmitz, Henry, The treatment of benign hemorrhage of the female genito-urinary tract by radiation, 872
Burnam, Curtis F. and Ward, Grant E., Recent developments in protective methods and appliances as used in radium therapy, 625

Burnett, Francis Lowell, The intestinal rate and the form of the feces, 599
Burnham, M. P., Importance of indirect roentgen findings in chronic infection of the biliary ducts and gall-bladder, 105
Burns, roentgen, and roentgen dosage, H. Kurtzahn, Abstract, 1020

Cachexia, roentgen, and roentgen sickness, concerning, Henri Hirsch, Abstract, 1002
Calcification of the ovary, T. C. Bost, Abstract, 506
Calculi, renal, roentgen diagnosis of, M. Sgalitzer, Abstract, 1009
  Shadowless renal, Roger Colgate Graves, Abstract, 331
  Urinary, a plea for the use of the roentgenoscope in the diagnosis of, J. L. Tabb, 722
Calculosa, pericarditis (report of a new case discovered roentgenologically), James T. Case, Abstract, 675
Cancer, arise, does, in chronic gastric ulcer? William Carpenter MacCarty, Abstract, 174
  A skin, following exposure to radium, Ward J. MacNeal and George S. Willis, Abstract, 505
  Cases, the administration of morphin to, Maurice Renaud, Abstract, 505
  Control, the relation of radiology to, Thomas A. Groover, Abstract, 256
  Esophageal, the roentgen diagnosis of disease of the esophagus, especially, Max Sgalitzer, Abstract, 934
  Immunity, two important points from the radium therapist's standpoint regarding, Carroll Chase, 167
  Le, des radiologistes, Ledoux-Lebard, Abstract, 340
  Of the cervix uteri, concerning regular and general reaction of the organism following radiation treatment of, G. Roussy, S. Laborde, R. Leroux and Ed Peyre, Abstract, 331
  Of the esophagus, further observations on the radium treatment of, with a review of forty-four cases so treated, R. Walter Mills and John B. Kimbrough, 148
  Of the female generative organs, the use of radium in, Harold Bailey and Edith Quimby, Abstract, 341
  Of the larynx treated by radium, Douglas Quick and Fred M. Johnson, Abstract, 83
  Of the rectum, the treatment by radiation of, Harry H. Bowing and Frank W. Anderson, 230
  Of the rectum, treatment of, Robert C. Coffey, Abstract, 341
  Patients, the influence of *x*-ray treatment on the complement content of the blood of: biological reaction of *x*-rays, Carl F. Cori, 831
  Roentgen therapy of, prognosis of the, changes in the blood picture and its value in the, H. Zumpe, Abstract, 930
  Skin, the treatment of, by *x*-rays, radium and electrocoagulation, George E. Pfahler, Abstract, 254
  Superficial, the treatment of, with statistics and technique, D. T. Quigley, 161
  The biology and radiation therapy of, Perthes, Abstract, 921
  The radiation treatment of, the error of division and too frequent repetition of doses in, Cl. Regaud, Abstract, 255
  The treatment of, the problem of radium and surgery in, A. Strauss, Abstract, 339
  Uterine, contribution to the roentgen and radium treatment of, M. Spinelli, Abstract, 1003
    New points in the treatment of, with radium, Severin Nordentoft, Abstract, 1008
    Radium treatment of, O. Beuttner, Abstract, 765
Carcinoma, breast, intrathoracic changes following roentgen treatment of, T. A. Groover, A. C. Christie and E. A. Merritt, 471
  Duration of cure of operated breast, with and without prophylactic *x*-ray treatment, V. D. Hütten, Abstract, 500
  Esophageal, the technique of radiation therapy of, James T. Case, 859
  Mammary, radical surgery on, the value of postoperative irradiation following, Anschütz and Hellmann, Abstract, 1011
  Of esophagus, treatment of, by deep *x*-ray therapy, A. H. Pirie, 459
  Of the bladder and prostate, technique of the treatment of, by a combination of surgery, electrocoagulation, radium implantation and roentgen rays, B. A. Thomas and G. E. Pfahler, Abstract, 254
  Of the breast, deep roentgenotherapy in the treatment of, George E. Pfahler, 566
    Its combined treatment with surgery, *x*-ray and radium, Wm. J. Cassidy, Abstract, 334
    Primary or roentgen, combination of tuberculosis with, Fränkel, Abstract, 929
    Results and technique in the treatment of, by radiation, Burton J. Lee, 62
    X-ray treatment of, Arthur W. Erskine, Abstract, 257
  Cervix, life expectancy after radioactive treatment of, Schweitzer, Abstract, 1009
  Cervix uteri, the technique of the treatment of, with a combination of *x*-rays and radium rays, Henry Schmitz, 219
  Esophagus with perforation of the aorta: observations on radium therapy, James G. Carr and C. W. Hanford, Abstract, 83
  Floor of the mouth, Douglas Quick, 461
  Mouth, radium treatment of, L. R. Taussig, Abstract, 847
  Small bowel, Milton M. Portis and Sidney A. Portis, 419
  Supra-ampullary portion of the duodenum, N. B. Herman and Wm. C. Von Glahn, Abstract, 417
  Uterine cervix, a study of the action of measured radiation doses on, Henry Schmitz, 781
  Uterus, radiation of, Abstract, 80
  Of vertebrae, two cases of localized metastatic, without demonstrable primary lesion, Cyril P. O'Boyle, 711
  Rectal, the roentgen treatment of, an apparatus for the exact determination of the central ray in, Ernst Seitz and Wilhelm Rieder, Abstract, 932
  Spinal, in cases having an unrecognized primary focus, a roentgenological contribution to the diagnosis of, Thomas Scholz, Abstract, 254
Carcinomata, principles of radiotherapy of, especially of uterine and mammary carcinomata, E. Opitz, 312
Carcinomatous tissues, the effect of roentgen rays on the mitotic cells in, and on the blood-vessels, Albert Reichold, Abstract, 592
Cardiac and pulmonic changes following inoculation with foreign protein, I. Edward Liss, 435
  Measurements, preliminary observations of, in children, R. M. Tyson and F. F. Borzell, 559
Cardiospasm associated with esophageal diverticula, Porter P. Vinson, Abstract, 850
  In the aged, J. H. Zaaijer, Abstract, 587
Carelli, Humberto H., Pneumoperitoneum, 259
"Cascade stomach," etiology of the, Feissly and Fried, Abstract, 1013
Case, James T., The technique of radiation therapy of esophageal carcinoma, 859

Castration, human, by the *x*-ray (Ein Beitrag zur Roentgen-Kastration beim Mann), H. R. Schinz, Abstract, 852

Cathcart, J. W., Water-cancer or gangrenous stomatitis treated with the *x*-ray, 561

Caution, necessity for, in the employment of high voltage roentgen rays as a therapeutic agent against malignant disease: acute adrenal insufficiency and death as sequelae, Frank Smithies, Abstract, 414

Cervix, carcinoma of the, life expectancy after radioactive treatment of, Schweitzer, Abstract, 1009

Chart, a history, for radium therapy, Carroll Chase, 163

Charts, anatomical cross-section, in estimating *x*-ray dosage, Arthur U. Desjardins, 134

Chase, Carroll, A history chart for radium therapy, 163
  Two important points from the radium therapist's standpoint regarding cancer immunity, 167

Chest, a complete examination of the, James A. Honeij, Editorial, 247
  Diseases of the, clinical roentgenology of, H. Wessler and L. Jaches, Book review, 919
  New growths within the, J. N. Hall, 182
    x-ray diagnosis, Samuel B. Childs, 175
  Wall, anterior, the relation of the heart, pericardium and the heart valves to the, Leon T. LeWald, Abstract, I, 333; II, 1007
  X-ray examination of the, B. Hudson and P. G. Sutton, Abstract, 930

Child of twenty-nine days, congenital sarcoma of kidney in a, Clyde Leroy Deming, Abstract, 587

Children, preliminary observations of cardiac measurements in, R. M. Tyson and F. F. Borzell, 559

Childs, Samuel B., New growths within the chest, *x*-ray diagnosis, 175

Chinese bound feet, Joseph L. Harvey, 911

Chondrosarcoma, periosteal, S. Kleinberg, Abstract, 1000

Christie, A. C., Merritt, E. A. and Groover, Thos. A., A new tube holder for roentgen therapy, 564
  A review of the treatment of hyperthyroidism by all methods, with a summary of the authors' experience with roentgen therapy, 385
  Intrathoracic changes following roentgen treatment of breast carcinoma, 471

Clark, J. H. and Bower, J. O., A preliminary report of the action of buried radium on diseased thyroids in man, 875
  The resistance of the thyroid gland to the action of radium rays. The results of experimental implantation of radium needles in the thyroid of dogs, 632

Clark, William L., The rôle of radium needles in the treatment of neoplastic diseases, 204

Climacteric hemorrhages, results of the treatment of, by radium therapy in the Radium Clinic, Stockholm, James Heyman, Abstract, 338

Clinical roentgenology of diseases of the chest, H. Wessler and L. Jaches, Book review, 919

Coccidioidal granuloma, Raymond G. Taylor, 551

Colic, gall-stone, condition of the stomach during, roentgenologic study of the, Hans Smidt, Abstract, 1019

Colon, descending, intussusception of the, F. Karewski, Abstract, 1014
  Diverticula of the, Victor Pauchet, Abstract, 1013
  Gall-stones in the, a case of left-sided renal stone together with, Lotsy, Abstract, 1000
  Inflation, the diagnostic value of, in the diagnosis of spleen, liver and gall-bladder disease, Henzelmann, Abstract, 1016

Comparison of clinical and roentgenological observations in pulmonary tuberculosis, a, Frank S. Bissell, 428

Condylomata acuminata, roentgen treatment of, Stein, Abstract, 80

Cook, Orrin S., Acute mediastinal abscess: report of four cases in children, 696

Coolidge, W. D. and Moore, C. N., A water-cooled high-voltage *x*-ray tube, 884

Cori, Carl F., Biological reaction of *x*-rays: the influence of *x*-ray treatment on the complement content of the blood of cancer patients, 830
  And Pucher, G. W., Biological reactions of *x*-rays: effect of radiation on the nitrogen and salt metabolism, 738

CORRESPONDENCE:
  A. E. Barclay, 329
  N. Ernest Dorsey, 501, 762
  Wm. A. Evans, 991
  H. Flecker, 76
  P. M. Hickey, 409
  Charles M. Johnston, 173
  V. M. Moore, 410
  George E. Pfahler, 169
  Francis B. Sheldon, 502
  C. P. Smith, 170

Coxa plana, the definite form of the, H. Waldenström, Abstract, 336

Cranial hyperostosis overlying endothelioma of the meninges, the nature of, D. B. Phemister, Abstract, 850

Crouse, Hugh W., The *x*-ray in neurological diagnosis: its shortcomings and possibilities, 437

Crow, Lloyd B., Examination of the posterior mediastinal glands in the early recognition of pulmonary tuberculosis, 699

Cyst, echinococcus, of the tibia, Lesi, Abstract, 1019

Damage from irradiation treatment with and without changes in the skin, Wetzel, Abstract, 931

Dandy, Walter, Localization of brain tumors by cerebral pneumography, 610

Dangers, possible, in connection with the use of *x*-rays, and how to avoid them, John S. Shearer, 240

Dann, David S. and Holmes, George W., Cardiac pneumofibrosis, 343

Dean, Archie L., Results of skin tests made to determine an objective dose for radium radiations, 654

Death after pneumoperitoneum, G. Gaertner, Abstract, 679
  Joseph, Abstract, II, 676

Del Buono, P., Deep roentgen therapy and skin reactions, 745

Dermatitis artifacta simulating roentgen dermatitis, George M. MacKee and George C. Andrews, 617
  Roentgen, vs. salvarsan dermatitis, E. Galewsky, Abstract, 1020

Desjardins, Arthur U., Anatomical cross-section charts in estimating *x*-ray dosage, 134

Dessauer charts, the, inaccuracy of, the use of isodosis curves in *x*-ray therapy showing the, Charles Gottlieb, 896

Diabetes insipidus and exophthalmus with report of a case, defects in the membranous bones, L. C. Grosh and J. L. Stifel, Abstract, 332

Diagnosis, the differential, between tuberculosis and lung abscess, Leon T. LeWald and Nathan W. Green, Abstract, 1008
  The *x*-ray in neurological, its shortcomings and possibilities, Hugh W. Crouse, 437

Diaphragm, flat, of spiral design in roentgenography, Harold S. Sawford, 737
  Idiopathic elevation of the, the diagnosis and mechanism of, Wels, Abstract, 933
  Immobility of the, with report of cases of bilateral immobility, J. H. Pryor, Abstract, 766

Diaphragming of the secondary radiation, on a device for the, during roentgen diagnosis, Åke Åkerlund, Abstract, 338
Dickson, W. H., Diagnosis of obscure abdominal lesions by the roentgen gastrointestinal examination, 540
Digestive disturbances in infants and children, Charles Gilmore Kerley and Leon Theodore LeWald, Book review, 845
  Tract, the, movement of the mucous membrane of, studies of the mechanism of, Gösta Forssell, 87
Discussion on paper by Prof. William Duane on Measurement of dosage by means of ionization chambers, Otto Glasser, 493
  Papers of Drs. Barclay, Alvarez and Forssell, 103
    Drs. Hall, Childs, Holmes and Dann, 350
    Drs. McCoy, Osmond and Kinney, 380
    Drs. Withers and Schmitz, 790
Diverticulum from the anterior surface of the stomach near the cardio-esophageal junction, Leonard J. Ravenel, 904
Dogs, the thyroid of, the results of experimental implantation of radium needles in. Resistance of the thyroid gland to the action of radium rays, the, J. O. Bower and J. H. Clark, 632
Dosage in deep roentgen therapy from the biological point of view, Holzknecht, Abstract, 1003
  Measurement of, by means of ionization chambers, William Duane, 399
  Roentgen and radium, the problem of, Erich Opitz, Abstract, 1013
    And roentgen burns, H. Kurtzahn, Abstract, 1020
  X-ray, anatomical cross-section charts in estimating, Arthur U. Desjardins, 134
    And radium, principles of, Albert Bachem, Book review, 992
Dose, percentage depth, the measure of the, with Kienböch strips after the method of Baumeister, Kothen, Abstract, 1001
Dosimetry in radiotherapy, the economics of, Gioacchino Failla and Edith H. Quimby, 944
Duane, William, Ionization methods of measuring *x*-ray dosage, 935
  Measurement of dosage by means of ionization chambers, 399
Dunham, Kennon and Norton, Vera V., An *x*-ray study of the absorption of tuberculous exudate within the lung, 112
Duodenal adhesions, clinical and roentgenological observations in cases of, Foerster, Abstract, 82
  Bulb, roentgenological studies of the, Åke Åkerlund Book review, 310
  Motility, Homer Wheelon, Abstract, 411
  Stenosis following an ancient tuberculous peritonitis, F. Hochstetter, Abstract, 415
    Tuberculous peritonitis, Hochstetter, Abstract, 1013
Duodenojejunal diverticula, Zehbe, Abstract, I, 1014 and II, 1018
Duodenum, a case of extreme dilatation of the, due to chronic obstruction, R. E. Roberts, Abstract, 253
  Pseudo-diverticulum of the, Herrnheiser, Abstract, 1020
  Roentgen investigation of the, Schütze, Abstract, 1011
Dystrophia adiposogenitalis, hypophyseal, two cases of, and their treatment by means of the roentgen rays, Rauschburg, Abstract, 86

EDITORIALS:
  Cancer research prize, the Dr. Sofie A. Nordhoff-Jung, 247
  Case, James T., A visit to some South American Radiologists, 754
  Central Illinois Radiological Society, officers of, 763
  Cinema-cardio-roentgenograms, 328
  Duane, Professor, joins editorial staff, 503
  Enfield, Charles D., Home-made *x*-ray diagnosis, 581
  Future of the Journal, announcement of plans for the, 846
  George, Dr., honored, 503
  Honeij, James A., A complete examination of the chest, 247
  Imboden, Dr. H. M., 990
  Leonard Prize Committee, report of, 918
  National Board, examinations of, 329
  New England Society, officers of, 665
  New York Roentgen Society, officers of, 918
  Passing of Roentgen, the, 327
  Radiological Society of Medicine of France, officers of, 503
  Safety committee, report of, presented at Los Angeles meeting of A. R. R. S., 246
 Meetings:
  Eighth annual of American Radium Society, 248
  Fifth annual of Eastern Section A. R. R. S., announcement of, 918
  Fourth annual of Central Section A. R. R. S., preliminary program, 171, report of, 329
    of Eastern Section A. R. R. S., preliminary program, 76, report of, 169
  Italian Society for Medical Radiology, announcement of, 665
  Southern Medical Association, announcement of, 846
  Twenty-fourth annual of A. R. R. S., announcement of, 409, reduced rates for, 583, exhibit of film and slides at, 584, preliminary program, 664, report of, 990
Effect of roentgen rays on the mitotic cells in carcinomatous tissues and on the blood-vessels, the, Albert Reichold, Abstract, 592
Elbow-joint, anterior dislocation at the, Frederick J. Tees, Abstract, 587
Electricity, static, of the roentgen tube, studies on, Schreus, Abstract, 1001
Emerson, Chas. P. and Beeler, Raymond C., An unusual case of double spontaneous pneumothorax, 126
Enteroliths, W. W. Boardman, 369
Enzyme action, the effect of *x*-rays on, R. D. Lawrence, Abstract, 253
  The immediate effect of radium and *x*-rays on, S. Clement Roth and John J. Morton, 407
Epibulbar neoplasms, malignant, non-surgical treatment of, Edward B. Heckel, Abstract, 255
Epiphysis of the femur, complete anterior dislocation of the distal, Theodore West, 519
Erlangen Clinic, the technique of the: deep *x*-ray therapy, W. Pilger, Abstract, 330
Error, the, of division and too frequent repetition of doses in the radiation treatment of cancer, Cl. Regaud, Abstract, 255
Errors in the diagnosis of foreign bodies in the air passages, Porter P. Vinson, 908
Erskine, Arthur W. and Smith, Scott W., A comparative study of the efficiency of various filter materials, 881
Erythema dose, intestinal reaction to, Charles L. Martin and Fred T. Rogers, 11
Erythremia, the roentgen-ray treatment of, Eugene P. Pendergrass and Henry K. Pancoast, Abstract, 335

Esophageal cancer, the roentgen diagnosis of disease of the esophagus, especially, Max Sgalitzer, Abstract, 934
  Carcinoma, the technique of radiation therapy of, James T. Case, 859
  Diverticula, cardiospasm associated with, Porter P. Vinson, Abstract, 850
Esophagus, cancer of the, radium treatment of, J. Guisez, Abstract, 1000
  Carcinoma of, treatment of, by deep *x*-ray therapy, A. H. Pirie, 459
Evans, William A., The value of the roentgen study of mastoid disease in children under five, 382
  And Leucutia, T., Results of deep roentgen treatment of gastrointestinal malignancies, 793
Eveleth, Fred S., Treatment of a case of primary mediastinal tumor of the lung by *x*-rays after medical resources were exhausted, 802
Examination of the renal and gall-bladder areas, observations on the lateral position and other methods of, John Thomson-Walker and Robert Knox, 681
Eyes, damage to the, the question of, from roentgen irradiation, Birch-Hirschfeld, Abstract, 931

Failla, Gioacchino and Quimby, Edith H., The economics of dosimetry in radiotherapy, 944
  Ionization measurements, 48
Fallopian tubes, bilateral calcification in the, C. C. Birkelo, Abstract, 764
Farinas, Pedro L., Diaphragmatic hernia of the stomach, 187
Feces, the intestinal rate and the form of the, Francis Lowell Burnett, 599
Feet, Chinese bound, Joseph L. Harvey, 911
Female genitourinary tract, the treatment of benign hemorrhage of the, by radiation, Henry Schmitz and Harry E. Bundy, 872
Femur, a child's, a rare roentgen finding in, Weil, Abstract, 1009
  Epiphysis of the, complete anterior dislocation of the distal, Theodore West, 519
Fetal development, effects of irradiation on, Harold Bailey and Halsey J. Bagg, Abstract, 677
Fibrinous bronchitis, F. Hase Rodenbaugh, 843
Fibrochondroma, malignant, of the stomach, A. Charrier and Riou, Abstract, 848
Fibroids, operative versus radiological treatment of, S. Kjaergaard, Abstract, 764
  The mechanism of retrogression of human uterine, Keiffer, Abstract, 415
Fibro-myomes de l'utérus, des réfractaires à la roentgenthéraphie, existe-ent-ils? M. Béclère, Abstract, 339
Filter, a device to prevent the omission of a, in deep roentgen therapy, George E. Pfahler, 562
  Aluminum, a biological coefficient for the, Francis B. Sheldon, 307
  Materials, a comparative study of the efficiency of various, Arthur W. Erskine and Scott W. Smith, 881
Fistula, parotid, radiation as an aid in the operative treatment of, H. Schaedel, Abstract, 1008
  Ureteral, visualization of, by the *x*-rays, A. Lichtenberg, Abstract, 1011
Fistulae, salivary, temporary sterilization of the parotid by *x*-rays in the treatment of, F. W. Kaess, Abstract, 1008
Fluoroscope in the diagnosis of diseases of the heart, Louis Faugeres Bishop, Abstract, 676
Fluoroscopy, the technique of: description of a new appliance, L. Drüner, Abstract, 1002
Foot, subastragaloid dislocation of the, Beveridge H. Moore, Abstract, 411
Forceps for cleaning radium needles and tubes, J. S. Ullman, 989
Forearm at the elbow, forward dislocation of both bones of the, Isidore Cohn, Abstract, 411
Foreign bodies, errors in the diagnosis of, in the air passages, Porter P. Vinson, 908
  Body, an interesting *x*-ray study of a: honey locust seed in the right bronchus, C. E. Purcell, Abstract, 413
    A relatively large, in the orbit, Percy Brown, 842
Forssell, Gösta, Studies of the mechanism of movement of the mucous membrane of the digestive tract, 87
Fractures, in the open treatment of, the value of Grant's pins, as seen roentgenologically, D. Y. Keith and J. Paul Keith, 195
  Pathological, *x*-ray treatment of, Kohler, Abstract, 85
Freidrich, W., The problem of ray dosage, 6

Gall-bladder disease, advances made in the roentgen-ray study of, Dorwin Palmer, 901
  Pathology, secondary signs of, Ralph D. Leonard, 521
Gastric secretion, the influence of roentgen rays on, Wachter, Abstract, 929
  Stimulation, contribution to the study of, by *x*-rays, Simonetti, Abstract, 850
  Ulcer, healed, fallibility of roentgenologic evidence of, Edward Hollander, Abstract, 412
Gastrointestinal malignancies, results of deep roentgen treatment of, William A. Evans and T. Leucutia, 793
  Tract, actinomycosis of the, James Chester Brogden, Abstract, 174
Gastroptosis and the shape of the thorax, Faber, Abstract, 849
Gaylord, Harvey R. and Stenstroem, K. Wilhelm, Comparative measurements between radium and *x*-rays concerning energy absorbed at depth, 56
Generative processes after radium and roentgen deep therapy, a contribution to our knowledge of the, Werner, Abstract, 82
Giles, Roy G., Roentgen-ray study of non-luetic periosteal bone lesions, 593
Glands, examination of the posterior mediastinal, in the early recognition of pulmonary tuberculosis, Lloyd B. Crow, 699
  Of internal secretion, the influence of scattered radiation on, Manfred Fraenkel, Abstract, 1011
Glass retained in the hand and foot, Arthur S. Risser, 210
Glasser, Otto, Discussion on paper by Prof. William Duane on Measurement of dosage by means of ionization chambers, 493
  Isodose charts, 405
  Newer investigations of the problem of roentgen-ray dosage, 1
Goetsch's test and radiotherapy in diseases of the thyroid (épreuve de Goetsch et radiotherapie dans les affections du corps thyroide), Tarnauceanu, Abstract, 848
Gonorrhea, complications of, roentgen treatment of the, Wetterer, Abstract, 1002
Gonorrheal stricture of the rectum, C. Symonds, Abstract, 851
Goosmann, Charles, Results with modern radiotherapy in bladder tumors, 804
Gottlieb, Charles, The use of isodosis curves in *x*-ray therapy showing the inaccuracy of the Dessauer charts, 896
Grant's pins, the value of, in the open treatment of fractures as seen roentgenologically, D. Y. Keith and J. Paul Keith, 195

Granuloma, coccidioidal, Raymond G. Taylor, 551
  Combined roentgen and sunshine treatment of, Lahmann, Abstract, 1009
Grier, G. W., Stereoscopy of the accessory sinuses, 497
Groover, Thos. A., Christie, A. C. and Merritt, E. A., A new tube holder for roentgen therapy, 564
  A review of the treatment of hyperthyroidism by all methods, with a summary of the authors' experience with roentgen therapy, 385
  Intrathoracic changes following roentgen treatment of breast carcinoma, 471
Gynecology, the new roentgenotherapy in, James T. Case, Abstract, 335
  The uses of radium in, Thomas H. Cherry, Abstract, 250

Haenisch, F., Wilhelm Conrad Roentgen: In memoriam, 661
Hair, *x*-ray stimulation doses and diseases of the, Thedering, Abstract, 412
Hall, J. N., New growths within the chest, 182
Harvey, Joseph L., Chinese bound feet, 911
Head, an unusual shadow in the, interpreted as calcification in the left lateral ventricle, A. Robert Taft, 907
Hearing, impaired, certain forms of, the effect of small doses of roentgen rays in, D. C. Jarvis, 201
  Treatment of defective, by small doses of *x*-rays, John McCoy, 203
Heart, case of bullet in, with recovery, F. C. Swearingen, 454
  Diseases of the, fluoroscope in the diagnosis of, Louis Faugeres Bishop, Abstract, 676
  Pericardium and the heart valves, the relation of the, to the anterior chest wall, Leon T. LeWald, I, Abstract, 333; II, Abstract, 1007
  X-ray of the, Rolla G. Karshner, Abstract, 82
Heliotherapy, constitutional, new treatment lamps for, F. Kohl, Abstract, 1014
Hemangioma, radium treatment of, Beck, Abstract, 934
Hemorrhage, benign, the treatment of, of the female genitourinary tract by radiation, Henry Schmitz and Harry E. Bundy, 872
Hickey, Preston M., The effect of the war on the development of roentgenology, 70
Hodges, Paul C., Automatic operation of the Potter grid, 645
Hodgkin's disease, the use of radium in the treatment of the leucemias and, W. H. B. Aikins, 853
Holmes, George W. and Dann, David S., Cardiac pneumofibrosis, 343
Holzknecht, Guido, A review of the present status of deep roentgen therapy, 476
Hydrocephalus, internal, photography, ventriculoscopy and intraventricular, in, Temple Fay and Francis C. Grant, Abstract, 680
Hypernephroma, Harry B. Podlasky, 714
Hyperthyroidism, a review of the treatment of, by all methods, with a summary of the authors' experience with roentgen therapy, Thos. A. Groover, A. C. Christie and E. A. Merritt, 385
  Relative value of surgery and roentgen rays in the treatment of, Edward P. Richardson, Abstract, 585
Hypertrophie amygdalienne, la traitement de, par les rayons *x*, Th. Nogier, Abstract, 340
Hypophyseal tumor, a: case report, Dehn, Abstract, 1019

Iglauer, Samuel, *X*-ray diagnosis of unusual laryngotracheal esophageal conditions and diseases, 547
Ileocecal valve, insufficiency of the, G. Hromada, Abstract, 1018
Ileocolonic stasis, roentgenographic interpretation of, Ernest Charles Samuel, 721
Ilium, osteomyelitis of the, in children, Carl Bearse, Abstract, 588
Immobilizing patients, a simple method of, in the standing position, C. Harvey Jewett, 915
Ingber, I. S., Report of a case of adeno-papilloma of the stomach, 539
Injuries from roentgen rays in deep therapy, Herman Wintz, 140
Instrument for the implantation of bare radium emanation tubes into the tissues, an, William Neill, 871
Intensiometer, the, M. Saget, Abstract, 416
Intestinal rate and the form of the feces, the, Francis Lowell Burnett, 599
  Reaction to erythema dose, Charles L. Martin and Fred T. Rogers, 11
Intrathoracic changes following roentgen treatment of breast carcinoma, T. A. Groover, A. C. Christie and E. A. Merritt, 471
Ionization measurements, Gioacchino Failla, 48
  Methods of measuring *x*-ray dosage, Wm. Duane, 935
Irradiation, long-distance, the value of, in deep therapy, Haupt and Pinoff, Abstract, 1009
  On the body through irradiation of isolated organs, concerning the indirect damaging effects of, Fritz Poos, Abstract, 256
  Postoperative, the value of, following radical surgery on mammary carcinoma, Anschütz and Hellmann, Abstract, 1011
  Sickness, Rieder, Abstract, 1000
Isodose charts, Otto Glasser, 405
Isodosis curves, the use of, in *x*-ray therapy showing the inaccuracy of the Dessauer charts, Charles Gottlieb, 896

Jackson, J. B., A case of tuberculosis of the symphysis pubis, 806
Jarvis, D. C., The effect of small doses of roentgen rays in certain forms of impaired hearing, 201
Jenkinson, E. L., Roentgen-ray treatment of the thyroid, 814
Jewett, C. Harvey, A simple method of immobilizing patients in the standing position, 915
Joint, second metatarsophalangeal, typical disease of the, Alban Kohler, 705
Juvenilis, osteochondritis deformans, B. R. Kirklin, 701

Keith, D. Y. and Keith, J. Paul, The value of Grant's pins in the open treatment of fractures as seen roentgenologically, 195
Keith, J. Paul and Keith, D. Y., The value of Grant's pins in the open treatment of fractures as seen roentgenologically, 195
Keloids, radium treatment of, Ernest M. Daland, Abstract, 411
Kidney, calcified hydatid cysts of the, H. Minet, Abstract, 1002
  Horseshoe, the roentgenologic symptom-complex of, N. Voorhoeve, Abstract, 1006
Kimbrough, John B. and Mills, R. Walter, Further observations on the radium treatment of cancer of the esophagus with a review of forty-four cases so treated, 148
Kinney, Lyell Cary, The roentgen therapy of tinnitus aurium, 378.
Kirklin, B. R., Osteochondritis deformans juvenilis, 701
Knox, Robert and Thomson-Walter, John, Observations on the lateral position and other methods of examination of the renal and gall-bladder areas, 681
Kohler, Alban, Typical disease of the second metatarsophalangeal joint, 705

Larkin, A. James, Radium needles in malignant growths of the tongue: the time factor, 734
Laryngotracheal esophageal conditions and diseases, unusual, *x*-ray diagnosis of, Samuel Iglauer, 547

Larynx, cancer of the, treated by radium, Douglas Quick and Fred M. Johnson, Abstract, 83
Law, F. M., Errors in interpretations of lesions of the sinuses, 301
Leddy, Eugene T. and Weatherwax, J. L., Standardization of ionization measurements of intensity and measurements of scattered and secondary x-rays effective in producing an erythema, 488
Lee, Burton J., Results and technique in the treatment of carcinoma of the breast by radiation, 62
Leonard, Ralph D., Secondary signs of gall-bladder pathology, 521
Leucemias, the use of radium in the treatment of the, and Hodgkin's disease, W. H. B. Aikins, 853
Leucutia, T. and Evans, William A., Results of deep roentgen treatment of gastrointestinal malignancies, 793
Leukemia following radium treatment, blood changes in myelogenous, B. R. Whitcher, Abstract, 174
  Myelomatous, warning against overdosing with x-rays in cases of, W. Parrisius, Abstract, 592
Levi, Irwin P., Suppurative osteomyelitis of the left side of the pelvis, 208
Liberson, Frank, A simplified roentgenographic technique based on experimental evidence, 647
Life expectancy of the uterine cancer patient, P. W. Siegel, Abstract, 1009
Light waves, a study of, in their relation to rickets, Alfred F. Hess and Mildred Weinstock, Abstract, 589
Linitis plastica, Albert F. R. Andresen, Abstract, 847
Liss, I. Edward, Pulmonic and cardiac changes following inoculation with foreign protein, 435
Little, C. C. and Bagg, H. J., The occurrence of two heritable types of abnormality among the descendants of x-rayed mice, 975
Loose filter, experiences with the, Hirsch, Abstract, 1001
Lorenz, Egon and Rayewsky, Boris, Measurement of the absorption coefficient of water and aluminum for hard x-rays, 890
Loucks, R. E., Radium treatment of toxic goiter with metabolic deductions, 767
Lumbar transverse processes, the, Morris I. Bierman, 456
Lung, an x-ray study of the absorption of tuberculous exudate within the, Kennon Dunham and Vera V. Norton, 112
  Resection of the, for suppurative infections, Howard Lilienthal, Abstract, 340
Lungs, actinomycosis of the, simulating tuberculosis, Herman Besser, Abstract, 765
  Of normal children, some unappreciated findings in the, Charles R. Austrian and Frederick H. Baetjer, Abstract, 766

MacKee, George M. and Andrews, George C., Dermatitis artifacta simulating roentgen dermatitis, 617
Malignancies, cutaneous, fifteen years' experience with the fractional dose method of treating, J. M. Martin, 726
Malignancy, deep-seated, clinical problems in roentgen therapy of, Chas. L. Martin and J. M. Martin, 818
Malignant disease, the clinical results of the treatment of, J. H. Webster, Abstract, 928
"Marble bones," report of a case of so-called, with a review of the literature and a translation of an article, William G. Alexander, 280
Martin, Charles L. and Martin, J. M., Clinical problems in roentgen therapy of deep-seated malignancy, 818
  And Rogers, Fred T., Intestinal reaction to erythema dose, 11
Martin, J. M., Fifteen years' experience with the fractional dose method of treating cutaneous malignancies, 726
  And Martin, Charles L., Clinical problems in roentgen therapy of deep-seated malignancy, 818
Mastoid disease, the value of the roentgen study of, in children under five, Wm. A. Evans, 382
Mavor, James W., Studies on the biological effects of x-rays, 968
McCoy, John, Treatment of defective hearing by small doses of x-rays, 203
McKinney, Joseph T., Tumors of the pituitary gland, 835
Measurements, standardization of ionization, of intensity and measurements of scattered and secondary x-rays effective in producing an erythema, J. L. Weatherwax and Eugene T. Leddy, 488
Mediastinal abscess, acute: report of four cases in children, Orrin S. Cook, 696
Meninges, calcification and ossification of the, F. Christopher and A. E. Halstead, Abstract, 848
  Endothelioma of the, the nature of cranial hyperostosis overlying, D. B. Phemister, Abstract, 850
Merritt, E. A., Groover, Thos. A. and Christie, A. C., A new tube holder for roentgen therapy, 564
  A review of the treatment of hyperthyroidism by all methods, with a summary of the authors' experience with roentgen therapy, 385
  Intrathoracic changes following roentgen treatment of breast carcinoma, 471
Metabolism, the effect of artificial high altitude sun on, (Alpine lamp), Lasch, Abstract, 86
Metatarsophalangeal joint, second, typical disease of the, Albert Kohler, 705
Method, fractional dose, fifteen years' experience with the, of treating cutaneous malignancies, J. M. Martin, 726
Mice, x-rayed, the descendants of, the occurrence of two heritable types of abnormality among, C. C. Little and H. J. Bagg, 975
Mills, R. Walter and Kimbrough, John B., Further observations on the radium treatment of cancer of the esophagus with a review of forty-four cases so treated, 148
Monoarthritis, subacute and chronic, as the only manifestation of luetic infection, Cattaneo, Abstract, 1017
Moore, C. N. and Coolidge, W. D., A water-cooled high-voltage x-ray tube, 884
Moore, Sherwood, Observations on osteitis deformans, 507
Morphin, the administration of, to cancer cases, Maurice Renaud, Abstract, 505
Morrow, Howard and Taussig, Laurence R., Radium therapy of vascular nevi, 867
  Statistics and technique in the treatment of malignant disease of the skin by radiation, 212
Morton, John J. and Roth, S. Clement, The immediate effect of radium and x-rays on enzyme action, 407
Morton, Reginald, Deep x-ray therapy, 119
Mouth, carcinoma of the floor of the, Douglas Quick, 461
  Carcinoma of the, the radium treatment of, L. R. Taussig, Abstract, 847
Mucosa, the roentgenographic study of the, in normal and pathological states, Richard A. Rendich, 526
Mucous membrane of the digestive tract, studies of the mechanism of movement of the, Gösta Forssell, 87

Nasolacrymal passageways, roentgen-ray studies of the, Don M. Campbell, John M. Carter and Howard P. Doub, Abstract, 83

Nasopharynx, benign and malignant growths of the, and their treatment with radium, S. J. Crowe and J. W. Baylor, Abstract, 849
Neill, William, An instrument for the implantation of bare radium emanation tubes into the tissues, 871
Neoplastic diseases, the rôle of radium needles in the treatment of, William L. Clark, 204
Nevi, vascular, radium therapy of, Howard Morrow and Laurence R. Taussig, 867
Newborn, gastrointestinal examination of the, Vogt, Abstract, 1016
Nichols, Bernard H., Important points in the technique of roentgenological examinations of the urinary tract, 19
Nomogram, a simple, for the determination of radium skin doses, Edith H. Quimby, 574
Norton, Vera V. and Dunham, Kennon, An *x*-ray study of the absorption of tuberculous exudate within the lung, 112
Nuzum, F. R. and Ullmann, H. J., The bacteriology of irradiated tonsils, 396

O'Boyle, Cyril P., Two cases of localized metastatic carcinoma of vertebrae without demonstrable primary lesion, 711
Omentum, a third, M. I. Bierman and W. M. Jones, Abstract, 852
Operation in an irradiated field, Fritz König, Abstract, 1003
Opitz, E., Principles of radiotherapy of carcinomata especially of uterine and mammary carcinomata, 312
Orbit, a relatively large foreign body in the, Percy Brown, 842
Orthodiagraph, new form of, Groedel, Abstract, 932
Os acetabuli, roentgenological studies concerning an alteration in the upper wall of the os innominatum known as the, R. Rhule, Abstract, 679
Os calcis, secondary, Arthur Krida, Abstract, 589
Osmo regulation of roentgen tubes, Rzewuski, Abstract, 1004
Osmond, John D., Roentgen therapy of acute infections of the antrum and frontal sinus, 374
Ossification, premature, after separation of the lower radial epiphysis, Morris K. Smith, Abstract, 257
Osteitis deformans, observations on, Sherwood Moore, 507
  Fibrosa, H. Sauer, Abstract, 1015
Osteochondritis deformans juvenilis, B. R. Kirklin, 701
Osteoma of the skull, Carl W. Rand, Abstract, 851
Osteomyelitis of the ilium in children, Carl Bearse, Abstract, 588
  Progressive, of the frontal bone, H. B. Lemere, Abstract, 505
  Suppurative, of the left side of the pelvis, Irwin P. Levi, 208
Osteoporosis, post-traumatic, of the bones of the extremities (improperly called atrophy by the radiologists), Grynfelt, Abstract, 764
Osteopsathyrosis: report of a case, Donald M. Glover, Abstract, 1005
Osteosclerosis, congenital, a case of, R. K. Rhormley, Abstract, 852
  Fragilis generalista, George G. Davis, Abstract, 1001
Otitis media, sub-acute and chronic, with the use of the *x*-ray, treatment of, Robert Beattie, Abstract, 334
Ovary, calcification of the, T. C. Bost, Abstract, 506

Paget's disease, a rare case of, Eisler, Abstract, 1015
Palmare totale, su due casi di lussagione, dell'osso semilunare, Giuliano Chizzola, Abstract, 342
Palmer, Dorwin, Advances made in the roentgen-ray study of gall-bladder disease, 901
Pancreas, roentgen-ray stimulation of the, in experimental pancreatic deficiency, William F. Peterson and Clarence C. Saelhof, Abstract, 79
Paramaceia, a study of the combined action of *x*-rays and vital stains upon, W. M. Baldwin, Abstract, 852
Parker, Carl H., Report of three unusual abdominal cases, 605
Parotid, temporary sterilization of the, by *x*-rays in the treatment of salivary fistulae, F. W. Kaess, Abstract, 1008
Pelvioradiography after Fabre's method, J. Warren Bell, Abstract, 332
Pelvis, female, radium therapy with special reference to diseases of the: a rejoinder, Howard A. Kelly, Abstract, 590
  Suppurative osteomyelitis of the left side of the, Irwin P. Levi, 208
Perirenal insufflation of oxygen, W. C. Quinby, Abstract, 766
Peristalsis, gastric, new light on, Walter C. Alvarez, 31
Perisigmoiditis, a case of, verified by roentgen-ray study, S. I. De Jong and Aubourg, Abstract, 851
Peritonitis, tuberculous, duodenal stenosis following, Hochstetter, Abstract, 1013
Pfahler, George E., A device to prevent the omission of a filter in deep roentgen therapy, 562
  Deep roentgenotherapy in the treatment of carcinoma of the breast, 566
Physiotherapy technic, C. M. Sampson, Book review, 992
Pirie, A. Howard, Prognosis in tuberculosis of the lungs from examination by the *x*-rays, 366
  Treatment of carcinoma of esophagus by deep *x*-ray therapy, 459
Pituitary gland, tumors of the, Joseph T. McKinney, 835
Plastica, linitis, Albert F. R. Andresen, Abstract, 847
Pleura, encapsulated, as seen roentgenologically, Groedel, Abstract. 1003
Pneumofibrosis, cardiac, George W. Holmes and David S. Dann, 343
Pneumography, localization of brain tumors by cerebral, Walter Dandy, 610
Pneumonia, lobar, a study of, and its pulmonary complications by serial roentgenographic examination, L. R. Sante, 351
Pneumoperitoneum, Humberto H. Carelli, 259
  A case of death following, Joseph, Abstract, I, 80
  Artificial, diagnostic value of, in sterility in women, Bernhard Friedlaender, Abstract, 506
  As an aid in the diagnosis of subdiaphragmatic conditions, L. R. Sante, Abstract, 418
  Death after, G. Gaertner, Abstract, 679
    Joseph, Abstract, II, 676
  Indications for, Fritz Partsch, Abstract, 930
Pneumothorax, double spontaneous, an unusual case of, Chas. P. Emerson and Raymond C. Beeler, 126
Podlasky, Harry B., Hypernephroma, 714
Polycythemia, roentgen therapy of, with special consideration of the question of cure, Böttner, Abstract, 84
Polypi, nasal, roentgen therapy in the treatment of, James G. Ware, 579
Pomeroy, Lawrence A., A new radium chart, 229
Portio vaginalis, localization of the, in gynecological deep therapy, Gerhard Bartram, Abstract, 1002
Portis, Milton M. and Portis, Sidney A., Carcinoma of the small bowel, 419
Portis, Sidney A. and Portis, Milton M., Carcinoma of the small bowel, 419
Potter grid, automatic operation of the, Paul C. Hodges, 645
Powell, Eugene Vernon, An automatic switch for Bucky diaphragms, 67

Practical roentgen-spectrometry and its physical basis, K. Staunig, 479
Prostatic hypertrophy, chronic, roentgen therapy of, J. Thompson Stevens, 810
Pucher, G. W. and Cori, Carl F., Biological reaction of *x*-rays: effect of radiation on the nitrogen and salt metabolism, 738
Pulmonary abscess, importance of the roentgen examination in the determination of the proper method of treatment of, W. H. Stewart, 841
  Fibrosis, Bryce W. Fontaine, Abstract, 586
Pulmonic and cardiac changes following inoculation with foreign protein, I. Edward Liss, 435
Proceedings, abstract of, of the fourteenth session of the German Roentgen Ray Society, Munich, April 15–18, 1923, F. Haenisch, Abstract, 666
Pseudo-coxalgia: a clinical and radiographic study, Harry Platt, Abstract, 249
Pseudo-diverticulum of the duodenum, Herrnheiser, Abstract, 1020
Pyelography: common diagnostic errors, M. B. Wesson, Abstract, 848
Pyloric stenosis, rapidly developing complete: report of a case, Harold Swanberg, 905
Pylorus, case of inverted, obstructing a gastrojejunostomy aperture, James McClure and H. Ethelberta Claremont, Abstract, 764
Pyonephrosis, roentgen appearances of, A. Mosenthal, Abstract, 931
Pyorrhea alveolaris, report of results of *x*-ray treatment in, G. Von Poswik, 724

Quick, Douglas, Carcinoma of the floor of the mouth, 461
Quigley, D. T., The treatment of superficial cancer, with statistics and technique, 161
Quimby, Edith H., A simple nomogram for the determination of radium skin doses, 574
  And Failla, Gioacchino, The economics of dosimetry in radiotherapy, 944

Rabbit ovaries, the effects of radium upon, a contribution to the study of, Howard A. Weis, Abstract, 1005
Rachitis, prophylactic irradiation with high altitude sun in, Mengert, Abstract, 80
Radiation, statistics and technique in the treatment of malignant disease of the skin by, Howard Morrow and Laurence Taussig, 212
  Therapy, certain biological principles of, Sanford Withers, 776
    The efficiency of, U. V. Portmann, Abstract, 1001
  The treatment by, of cancer of the rectum, Harry H. Bowing and Frank W. Anderson, 230
Radioanaphylaxie, Foveau de Courmelles, Abstract, 339
Radiotherapy, principles of, of carcinomata especially of uterine and mammary carcinomata, E. Opitz, 312
Radium and *x*-ray, treatment by, R. Knox, Abstract, 1004
    Comparative measurements between, concerning energy absorbed at depth, Harvey R. Gaylord and K. Wilhelm Stenstroem, 56
  Applicator for small lesions, a, Nathan T. Beers, 643
  Benign and malignant growths of the nasopharynx and their treatment with, S. J. Crowe and J. W. Baylor, Abstract, 849
  Buried, a preliminary report of the action of, on diseased thyroids in man, J. O. Bower and J. H. Clark, 875
  Chart, a new, Lawrence A. Pomeroy, 229
  Emanation, a new device for retubing, Wilhelm Stenstroem, 311
    Slide rule for use in the field of therapeutics, the, John Ransom, 735
Radium tubes, an instrument for the implantation of bare, into the tissues, William Neill, 871
  Needles in malignant growths of the tongue: the time factor, A. James Larkin, 734
  The rôle of, in the treatment of neoplastic diseases, William L. Clark, 204
  Notes on the clinical value of, in the management of uterine hemorrhage, John Osborn Polak, Abstract, 675
  Radiations, results of skin tests made to determine an objective dose for, Archie L. Dean, 654
  Rays and *x*-rays, a combination of, the technique of the treatment of carcinoma of the cervix uteri with, Henry Schmitz, 219
  Skin doses, a simple nomogram for the determination of, Edith H. Quimby, 574
  Therapy, Frank Edward Simpson, Book review, 458
    As a treatment method in internal medicine, Falta and Högler, Abstract, 1010
    Pre-operative and postoperative: report of cases, dosage and methods, Ben R. Kirkendall, Abstract, 174
    Recent developments in protective methods and appliances as used in, Curtis F. Burnam and Grant E. Ward, 625
    With special reference to diseases of the female pelvis: a rejoinder, Howard A. Kelly, Abstract, 590
  The use of, in the treatment of disease, Turner Dawson, Abstract, 929
  Treatment of cancer of the esophagus, further observations on the, with a review of forty-four cases so treated, R. Walter Mills and John B. Kimbrough, 148
    Of toxic goiter with metabolic deductions, R. E. Loucks, 767
    In cancer of the cervix, Clark D. Brooks and Wm. R. Clinton, Abstract, 334
Ransom, John, The radium emanation slide rule for use in the field of therapeutics, 735
Ravenel, Leonard J., Diverticulum from the anterior surface of the stomach near the cardio-esophageal junction, 904
Ray, concerning a new kind of, W. C. Roentgen, 320
  Dosage, the problem of, W. Friedrich, 6
Rayewsky, Boris and Lorenz, Egon, Measurement of the absorption coefficient of water and aluminum for hard *x*-rays, 890
Rectum, gonorrheal stricture of the, C. Symonds, Abstract, 851
Renal and gall-bladder areas, examination of the, observations on the lateral position and other methods of, John Thomson-Walker and Robert Knox, 681
  Calculi, a case of, mistaken for echinococcus cyst, Révész, Abstract, 931
    Roentgen diagnosis of, M. Sgalitzer, Abstract, 1009
Rendich, Richard A., The roentgenographic study of the mucosa in normal and pathological states, 526
Review of the present status of deep roentgen therapy, a, Guido Holzknecht, 476
Rhinoscleroma, radium therapy of, Domenico Tanturri, Abstract, 934
Rickets, a, study of light waves in their relation to, Alfred F. Hess and Mildred Weinstock, Abstract, 589
Risser, Arthur S., Glass retained in the hand and foot, 210
Rodenbaugh, F. Hase, Fibrinous bronchitis, 843
Roentgen examination, importance of the, in the determination of the proper method of treatment of pulmonary abscess, W. H. Stewart, 841
  Findings, indirect, importance of, in chronic infection of the biliary ducts and gall-bladder, M. P. Burnham, 105

Roentgen gastrointestinal examination, diagnosis of obscure abdominal lesions by the, W. H. Dickson, 540
  Studies of patients with chronic deforming arthritis, R. G. Taylor, 424
  Irradiation of inflamed sweat glands in the axilla, Basch, Abstract, 85
  The passing of, Editorial, 327
Roentgenographic interpretation of ileocolonic stasis, Ernest Charles Samuel, 721
  Study of the mucosa in normal and pathological states, the, Richard A. Rendich, 526
  Technique, a simplified, based on experimental evidence, Frank Liberson, 647
Roentgenological examination of the urinary tract, important points in the technique of, Bernard H. Nichols, 19
Roentgenologist's report, the scope of the, Charles D. Enfield, Abstract, 680
Roentgenology, the effect of the war on the development of, Preston M. Hickey, 70
Roentgenoscope, a plea for the use of the, in the diagnosis of urinary calculi, J. L. Tabb, 722
Roentgenotherapy, deep, in the treatment of carcinoma of the breast, George E. Pfahler, 566
Roentgen-ray apparatus, high voltage, physical principles underlying the development of, C. N. Moore, Abstract, 342
  Dosage, newer investigations of the problem of, Otto Glasser, 1
  Study, advances made in the, of gall-bladder disease, Dorwin Palmer, 901
    Of non-luetic periosteal bone lesions, Roy G. Giles, 593
Roentgen rays, injuries from, in deep therapy, Herman Wintz, 140
  The measurement and dosage of the, the physical and technical foundation for, Frederick Voltz, Book review, 78
  Two cases of hypophyseal dystrophia adiposogenitalis and their treatment by means of the, Rauschburg, Abstract, 86
Roentgen-spectrometry, practical, and its physical basis, K. Staunig, 479
Roentgen stereoscopy without expensive special apparatus, Borggreves, Abstract, 82
  Therapy, a review of the present status of deep, Guido Holzknecht, 476
    Deep, dosage in, from the biological point of view, Guido Holzknecht, Abstract, 1003
      Progress in, Stark, Abstract, 1020
    In the treatment of nasal polypi, James G. Ware, 579
    Of polycythemia with special consideration of the question of cure, Böttner, Abstract, 84
Roentgen, W. C., Concerning a new kind of ray, 320
Roentgen, Wilhelm Conrad: In memoriam, F. Haenisch, 661
Rogers, Fred T. and Martin, Charles L., Intestinal reaction to erythema dose, 11
Roth, S. Clement and Morton, John J., The immediate effect of radium and *x*-rays on enzyme action, 407

Sacroiliac joint, some considerations of the, C. S. Lane Roberts, Abstract, 506
  Tuberculosis of the, H. C. Wardleworth Nuttall, Abstract, 588
Samuel, Ernest Charles, Roentgenographic interpretation of ileocolonic stasis, 721
Sante, L. R., A study of lobar pneumonia and its pulmonary complications by serial roentgenographic examination, 351
Sarcoma and tuberculosis, coincidence of, Erich Marsch, Abstract, 1012
  Congenital, of kidney in a child of twenty-nine days, Clyde Leroy Deming, Abstract, 587
Sarcoma melanotic, of eye, W. E. Schenck and Charles Goosmann, Abstract, 505
  (?) Of thigh, with secondary sarcoma (?) of inguinal region, liver and lungs: recovery after deep roentgen irradiation, J. Henry Schroeder, Abstract, 412
  Successfully treated by *x*-rays, F. Sanvenero, Abstract, 929
Sawford, Harold S., Flat diaphragm of spiral design in roentgenography, 737
Scaphoid, isolated disease of the, Barclay W. Moffat, Abstract, 411
Schmitz, Henry, A study of the action of measured radiation doses on carcinomata of the uterine cervix, 781
  The technique of the treatment of carcinoma of the cervix uteri with a combination of *x*-rays and radium rays, 219
  And Bundy, Harry E., The treatment of benign hemorrhage of the female genito-urinary tract by radiation, 872
Schwarz, Gottwald, The influence of *x*-ray therapy on benign and malignant growths dependent upon an apparent valid distinction between them, 622
Scleroderma, roentgen treatment of, Hammer, Abstract, 1003
Scope of the roentgenologist's report, the, Charles D. Enfield, Abstract, 680
Secondary signs of gall-bladder pathology, Ralph D. Leonard, 521
Shadows, annular: are they cavities or spontaneous pneumothoraces? Philip King Brown, 445
Shearer, John S., Possible dangers in connection with the use of *x*-rays and how to avoid them, 240
Sheldon, Francis B., A biological coefficient for the aluminum filter, 307
  The bone lesions of smallpox with report of cases, 35
Sinus disease and lung infections, Kennon Dunham and John H. Skavlem, Abstract, 335
Sinuses, accessory, stereoscopy of the, G. W. Grier, 497
  Lesions of the, errors in interpretations of, F. M. Law, 301
Skin, malignant disease of the, statistics and technique in the treatment of, by radiation, Howard Morrow and Laurence Taussig, 212
  Reactions, deep roentgen therapy and, P. Del Buono, 745
  Tests, results of, made to determine an objective dose for radium radiations, Archie L. Dean, 654
  Therapy, time-saving device for, Sze-Dau Tsiang, 917
Skull, osteoma of the, Carl W. Rand, Abstract, 851
Slide rule, the radium emanation, for use in the field of therapeutics, John Ransom, 735
Smallpox, the bone lesions of, with report of cases, Francis B. Sheldon, 35
Smith, Scott W. and Erskine, Arthur W., A comparative study of the efficiency of various filter materials, 881
Snider, W. L., A Bucky diaphragm with wide slits, 604
Soiland, Albert, Protective factors in modern highline *x*-ray work, 394
Spasms, gastric, F. Ramond, Ch. Jacquelin and Borrien, Abstract, 1004
Spectrometer, a new *x*-ray, W. E. Schall, Abstract, 927
Sphenoid sinus and the ethmoid cells, a new technique for the positive identification of the, Amedée Granger, Abstract, 678
Spine, the necessity for an immediate and thorough roentgenological study of all injuries to the, Halbert W. Chappell, Abstract, 415
Spleen, *x*-raying of the, to control uterine bleeding, L. Nurnberger, Abstract, 930

- Staining properties of tissue, the effect of roentgen rays upon the, experimental and histological investigations concerning, Ernst Albert Schmidt, Abstract, 1006
- Standardization of ionization measurements of intensity and measurements of scattered and secondary *x*-rays effective in producing an erythema, J. L. Weatherwax and Eugene T. Leddy, 488
- Staunig, K., Practical roentgen-spectrometry and its physical basis, 479
- Stenstroem, K. Wilhelm, A new device for retubing radium emanation, 311
  - And Gaylord, Harvey R., Comparative measurements between radium and *x*-rays concerning energy absorbed at depth, 56
- Sterility in women, diagnostic value of artificial pneumoperitoneum in, Bernhard Friedlaender, Abstract, 506
- Stevens, J. Thompson, Roentgen therapy of chronic prostatic hypertrophy, 810
- Stewart, W. H., Importance of the roentgen examination in the determination of the proper method of treatment of pulmonary abscess, 841
- Stomach, a case of syphilis of the, Samuel F. Weitzner, 537
  - A method for the opaque meal examination of the, S. Gilbert Scott, Abstract, 504
  - Compression of the, from high-lying colon, Artur Heinrich Hofmann, Abstract, 1012
  - Condition of the, during gall-stone colic, roentgenologic study of the, Hans Smidt, Abstract, 1019
  - Diaphragmatic hernia of the, Pedro L. Farinas, 187
  - Diverticulum from the anterior surface of the, near the cardio-esophageal junction, Leonard J. Ravenel, 904
  - Fibroma of, J. R. Cooper, Abstract, 418
  - Malignant fibrochondroma of the, A. Charrier and Riou, Abstract, 848
  - Pseudo-cancer of the, of syphilitic origin, Dalimier, Abstract, 1018
  - Report of a case of adeno-papilloma of the, I. S. Ingber, 539
- Stomatitis, gangrenous, or water-cancer, treated with the *x*-ray, J. W. Cathcart, 561
- Stone, renal, left-sided, a case of, together with gall-stones in the colon, Lotsy, Abstract, 1000
- Study of lobar pneumonia and its pulmonary complications by serial roentgenographic examination, a, L. R. Sante, 351
- Subphrenic abscess, operation for, J. Sommer, Abstract, 928
- Sunshine, natural, the position of the patient in relation to treatment with, Hackradt, Abstract, 1017
- Suprarenals, adrenalin content of the, following roentgen irradiation, experimental studies on the, O. David and Arnold Hirsch, Abstract, 1010
- Swanberg, Harold, Rapidly developing complete pyloric stenosis: report of a case, 905
- Swearingen, F. C., Case of bullet in heart with recovery, 454
- Sweat glands, inflamed, in the axilla, roentgen irradiation of, Basch, Abstract, 85
- Symphysis pubis, a case of tuberculosis of the, J. B. Jackson, 806
- Syphilis, an interpretative analysis of the diagnosis of, in consultant medical practice: two hundred syphilitic patients whose chief complaint was "stomach trouble," John H. Stokes and Philip W. Brown, Abstract, 249
  - Of the stomach, a case of, Samuel F. Weitzner, 537

- Tabb, J. L., A plea for the use of the roentgenoscope in the diagnosis of urinary calculi, 722
- Taft, A. Robert, An unusual shadow in the head interpreted as calcification in the left lateral ventricle, 907
- Taussig, Laurence R. and Morrow, Howard, Radium therapy of vascular nevi, 867
  - Statistics and technique in the treatment of malignant disease of the skin by radiation, 212
- Taylor, Raymond G., Coccidioidal granuloma, 551
  - Roentgen gastrointestinal studies of patients with chronic deforming arthritis, 424
- Teeth, unerupted Hutchinson's, the demonstration of, by the roentgen ray, J. H. Stokes and Boyd S. Gardner, Abstract, 412
- Testicle, malignant disease of the, *x*-ray treatment of intra-abdominal manifestations of, A. Béclère, Abstract, 1018
- Thomson-Walker, John and Knox, Robert, Observations on the lateral position and other methods of examination of the renal and gall-bladder areas, 681
- Thorax, the shape of the, and gastroptosis, Faber, Abstract, 849
- Thyroid gland, the resistance of the, to the action of radium rays. The results of experimental implantation of radium needles in the thyroid of dogs, J. O. Bower and J. H. Clark, 632
  - Irradiation, adhesions following, Hütten, Abstract, 1011
  - Roentgen-ray treatment of the, E. L. Jenkinson, 814
- Thyroids, diseased, in man, a preliminary report of the action of buried radium on, J. O. Bower and J. H. Clark, 875
- Tibia, echinococcus cyst of the, Lesi, Abstract, 1019
  - Spine of the, fracture of the, Richmond Stephens, Abstract, 587
- Tibial spine, fracture of the, Frank E. Blaisdell, Sr., Abstract, 931
- Tinnitus aurium, the roentgen therapy of, Lyell Cary Kinney, 378
- Tissue, inflamed connective, changes produced by roentgen rays in, A. A. Maximow, Abstract, I, 851; II, 932
- Tongue, malignant growths of the, radium needles in: the time factor, A. James Larkin, 734
- Tonsils, pathologic, the treatment of, a study of the tonsil question with a preliminary report of roentgen-ray and radium therapy in, Laura A. Lane, Abstract, 342
  - The bacteriology of irradiated, H. J. Ullmann and F. R. Nuzum, 396
- Toxic goiter, radium treatment of, with metabolic deductions, R. E. Loucks, 767
- Transposition of viscera (situs viscerum transversus). Report of a case without transposition of the usual abdominal reflex, John E. Summers, Abstract, 588
- Tsiang, Sze-Dau, Time-saving device for skin therapy, 917
- Tube beneath the table, the value of the, in deep roentgen therapy, O. Wille, Abstract, 1004
  - Holder, a new, for roentgen therapy, Thos. A. Groover, A. C. Christie and E. A. Merritt, 564
- Tuberculosis, a case of, of the symphysis pubis, J. B. Jackson, 806
  - And sarcoma, coincidence of, Erich Marsch, Abstract, 1012
  - Genital, combination of operative and roentgen therapy for, E. Vogt, Abstract, 1018
  - Hilum, in adults, Rüppel, Abstract, 81
  - Lung, the advantage of the roentgen examination in, Schinz, Abstract, 1012

Tuberculosis of the joints and its relation to the clinical aspect, a study on the roentgen aspect of, especially when under treatment by universal light baths, Edward Collin, Abstract, 336
  Of the lungs, prognosis in, from examination by the *x*-rays, A. Howard Pirie, 366
  Of the sacroiliac joint, H. C. Wardleworth Nuttall, Abstract, 588
  Pulmonary, a comparison of clinical and roentgenological observations in, Frank S. Bissell, 428
    Examination of the posterior mediastinal glands in the early recognition of, Lloyd B. Crow, 699
  Radiation treatment of, O. de la Camp, Abstract, 81
  Surgical, roentgen treatment of, Otto Jüngling, Abstract, 1003
    Treatment of, Lexer, Abstract, 85
  With primary or roentgen carcinoma of the breast, combination of, Fränkel, Abstract, 929
Tuberculous exudate within the lung, an *x*-ray study of the absorption of, Kennon Dunham and Vera V. Norton, 112
  Lymphadenitis, the results of our treatment of, by roentgen rays at Lund from 1908 to 1918, Lars Edling, Abstract, 337
Tumor, a hypophyseal: case report, Dehn, Abstract, 1019
  Of the base of the aorta, a hitherto undescribed, George R. Herrmann and Montrose T. Burrows, Abstract, 79
  Primary mediastinal, treatment of a case of, of the lung by *x*-rays after medical resources were exhausted, Fred S. Eveleth, 802
Tumors, bladder, results with modern radiotherapy in, Charles Goosmann, 804
  Bone, a case of multiple pulsating, J. Renfrew White, Abstract, 249
  Brain, localizing, in comatose patients, Walter E. Dandy, Abstract, 1000
  Deep-seated, advances in radiation therapy of, Rollin H. Stevens, Abstract, 444
  Malignant, radiotherapy of, G. Perthes, Abstract, 250
  Of the pituitary gland, Joseph T. McKinney, 835
  Of the trunk, genuine mixed, a contribution to the roentgenology of, Hugo Laurell, Abstract, 336
Tyson, R. M. and Borzell, F. F., Preliminary observations of cardiac measurements in children, 559

Ulcer, duodenal, roentgen symptomatology of, Franz M. Groedel, Abstract, 1017
Ulcers, high lesser curvature, diagnosis of, E. Wolff, Abstract, 1017
  Stomach, the roentgen appearance of, H. R. Schinz, Abstract, 1017
Ullman, J. S., Forceps for cleaning radium needles and tubes, 989
Ullmann, H. J. and Nuzum, F. R., The bacteriology of irradiated tonsils, 396
Ultraviolet light, the bactericidal action of, S. Bayne-Jones and Van der Lingen, Abstract, 252
Ureteral fistula, visualization of, by the *x*-rays, A. Lichtenberg, Abstract, 1011
Ureteropyelograms, a new method of making, Nathan P. Sears, Abstract, 339
Urinary tract, important points in the technique of roentgenological examinations of the, Bernard H. Nichols, 19
    Roentgenography of, during excretion of sodium iodid, Osborne, Sutherland, Scholl and Rowntree, Abstract, 587
Uropoietic system, *x*-ray differentiation of diseases of the, Baensch and Boeminghaus, Abstract, 1015
Uterine basocellular epithelioma, cure of, histological pictures representing the, Frans Daels, Abstract, 413
Uterine bleeding, to control, *x*-raying of the spleen, L. Nurnberger, Abstract, 930
  Cancer patient, life expectancy of the, P. W. Siegel, Abstract, 1019
  Cervix, carcinoma of the, a study of the action of measured radiation doses on, Henry Schmitz, 781
  Hemorrhage, the management of, notes on the clinical value of radium in, John Osborn Polak, Abstract, 675

Valeur séméiologique de la radiographie dans l'étude de la polysinusite grippale, Reverchon et Worms, Abstract, 851
Vaquez' disease cured by *x*-ray treatment, Frode Rydgaard, Abstract, 1009
Ventricle, left lateral, calcification in the, an unusual shadow in the head interpreted as, A. Robert Taft, 907
Vertebrae, carcinoma of, two cases of localized metastatic, without demonstrable primary lesion, Cyril P. O'Boyle, 711
Vinson, Porter P., Errors in the diagnosis of foreign bodies in the air passages, 908
Violet ray, the, experiments on the bactericidal action of, E. B. Fisher, Abstract, 849
Viscera, total transposition of, Henry H. Sherk, Abstract, 252
  Transposition of (situs viscerum transversus). Report of a case without transposition of the usual abdominal reflex, John E. Summers, Abstract, 588
Visceral adhesions and bands: normal incidence, John Bryant, Abstract, 255
Visceroptosis: normal incidence, John Bryant, Abstract, 253
Visit to some South American Radiologists, a, James T. Case, Editorial, 754
Von Poswik, G., Report of results of *x*-ray treatment in pyorrhea alveolaris, 724

Warning against overdosing with *x*-rays in cases of myelomatous leukemia, W. Parrisius, Abstract, 592
War, the effect of the, on the development of roentgenology, Preston M. Hickey, 70
Ward, Grant E. and Burnam, Curtis F., Recent developments in protective methods and appliances as used in radium therapy, 625
Ware, James G., Roentgen therapy in the treatment of nasal polypi, 579
Weatherwax, J. L. and Leddy, Eugene T., Standardization of ionization measurements of intensity and measurements of scattered and secondary *x*-rays effective in producing an erythema, 488
Weitzner, Samuel F., A case of syphilis of the stomach, 537
West, Theodore, Complete anterior dislocation of the distal epiphysis of the femur, 519
Wintz, Herman, Injuries from roentgen rays in deep therapy, 140
Withers, Sanford, Certain biological principles of radiation therapy, 776

X-ray and radium, treatment by, R. Knox, Abstract, 1004
  Department, the organization and equipment of an, A. E. Barclay, Abstract, 847
  Diagnosis, home-made, Charles D. Enfield, Editorial, 581
    New growths within the chest, Samuel B. Childs, 175
    Of unusual laryngotracheal esophageal conditions and diseases, Samuel Iglauer, 547
  Dosage, ionization methods of measuring, Wm. Duane, 935

- *X*-ray exposure identification, standardization of, Edw. S. Blaine, 303
  - In neurological diagnosis: its shortcomings and possibilities, the, Hugh W. Crouse, 437
  - Plates, development of, in bright light (safranine method), Glass, Abstract, 84
  - Therapy, deep, Reginald Morton, 119
    - Some results of, Reginald Morton and Harrie B. Lee, Abstract, 257
    - The influence of, on benign and malignant growths dependent upon an apparent valid distinction between them, Gottwald Schwarz, 622
  - Treatment in pyorrhea alveolaris, report of results of, G. Von Poswik, 724
    - In the diseases of the ear, nose and throat, William A. Evans, Abstract, 334
  - Tube, a water-cooled high-voltage, W. D. Coolidge and C. N. Moore, 884
  - Work, modern highline, protective factors in, Albert Soiland, 394
- *X*-rays and radium, comparative measurements between, concerning energy absorbed at depth, Harvey R. Gaylord and K. Wilhelm Stenstroem, 56
    - Rays, a combination of, the technique of the treatment of carcinoma of the cervix uteri with, Henry Schmitz, 219
  - Biological effects of, studies on the, James W. Mavor, 968
    - Reaction of, the influence of *x*-ray treatment on the complement content of the blood of cancer patients, Carl F. Cori, 830
      - Effect of radiation on the nitrogen and salt metabolism, Carl F. Cori and G. W. Pucher, 738
  - Hard, measurement of the absorption coefficient of water and aluminum for, Egon Lorenz and Boris Rayewsky, 890
  - Possible dangers in connection with the use of, and how to avoid them, John S. Shearer, 240

Paul B. Hoeber, 67–69 East 59th Street, New York

In Press · Ready in December

RADIUM REPORT
of the MEMORIAL HOSPITAL
(*SECOND SERIES*, 1923)

Contributors: Harold Bailey, m.d., Halsey J. Bagg, m.d., Benjamin S. Barringer, m.d., Archie L. Dean, m.d., James Ewing, m.d., William P. Healey, m.d., H. H. Janeway, m.d., Burton J. Lee, m.d., Douglas Quick, m.b. (Tor.), William L. Stone, m.d.

The work of the Memorial Hospital, New York, is generally accepted as the last word on Radium. Ever since the publication of the first report in 1917 there has been a growing demand for a new volume. Many changes in technical methods have been found necessary in the development of the work while the treatment of various forms of carcinoma was in the experimental stage. It is now the belief of the staff that *for the forms of carcinoma discussed* in this second report no radical changes are likely soon to occur either in the methods employed or in the character of the results obtainable by radiation. Case histories and controls are submitted and technique is discussed in detail.

To the medical man who gives radium treatment this book is indispensable. To *all* members of the profession it will prove invaluable in that it gives at a glance "The Truth About Radium."

SYNOPSIS OF CONTENTS

Janeway: The Present Status and Scope of Radium Therapy at the Memorial Hospital.
Janeway: Technical Principles Employed in Radium Therapy at the Memorial Hospital.
Quick: Malignant Diseases of the Intra-Oral Group.
Quick: Carcinoma of the Rectum.
Quick: New Growths of the Parotid Gland.
Quick: New Growths of the Eyeball and Orbit.
Quick: Malignant Diseases of the Skin.
Bailey: The Use of Radium in Cancer of the Female Generative Organs.
Bailey & Healey: Follow-up Results of 908 Cases of Uterine Cancer Treated by Radium.
Lee: Technique and Results in the Treatment of Carcinoma of the Breast by Radiation.
Lee: Treatment of Recurrent Inoperable Carcinoma of Breast by Radium and Roentgen Ray.
Barringer: Carcinoma of the Prostate.
Barringer: Radium Treatment of Carcinoma of the Bladder.
Barringer & Dean: Radium Therapy of Teratoid Tumors of the Testicle.
Stone: The Present Field for the Use of the X-Rays and Radium in the Treatment of Malignant Neoplasms.
Barringer & Dean: Epithelioma of the Penis.
Ewing: An Analysis of Radiation Therapy in Cancer.

OCTAVO, EXTRA CLOTH, OVER 200 PAGES, MANY ILLUSTRATIONS : PRICE $5.00

Published by PAUL B. HOEBER, Inc.
Publishers of The American Journal of Roentgenology & Radium Therapy
67-69 East 59th Street New York City

EXPERT SERVICE

Given on all makes of X-Ray machines

SPECIAL ATTENTION

Given to CORONALESS *Deep Therapy Installations*

WE MAKE NO CHARGE

For making Blue Prints for modern Coronaless
X-Ray Laboratories

Expert Service Men

available at all times for the following territory:
PENNSYLVANIA - SOUTHERN NEW JERSEY
DELAWARE - MARYLAND - VIRGINIA
NORTH AND SOUTH CAROLINA

M. H. Bresette X-Ray Co.

1821 MARKET STREET
PHILADELPHIA, PA.

3112 PIONEER AVENUE
PITTSBURGH, PA.

Distributors for

Acme-International X-Ray Co.

CHICAGO, ILLINOIS

CORONALESS X-RAY APPARATUS

ROENTGEN INTENSIFYING SCREEN
T-E
MADE IN U.S.A.

Dr. H. Threlkeld-Edwards
SOUTH BETHLEHEM, PA.

INTENSIFYING SCREEN PERFECTION

SPEED - DETAIL - UNIFORMITY

These three great essentials are peculiar to the T-E Intensifying Screen. The primary essential of a screen is speed—decreased time of exposure. Just as important a consideration is that perfection of detail which leaves no doubt in diagnosis. T-E uniformity makes annoying changes in technique unnecessary, and insures constantly perfect results. Many years of manufacturing experience stand back of the quality of T-E screens.

The T-E Cassette is the lightest on the market—the 14 x 17 weighs less than six pounds and is easily manipulated with one hand. T-E cassettes are guaranteed to produce absolute contact when the screens are properly mounted.

T-E Screens mounted in T-E Cassettes will eliminate all screen troubles—a safe investment that yields a big return in perfect service to you.

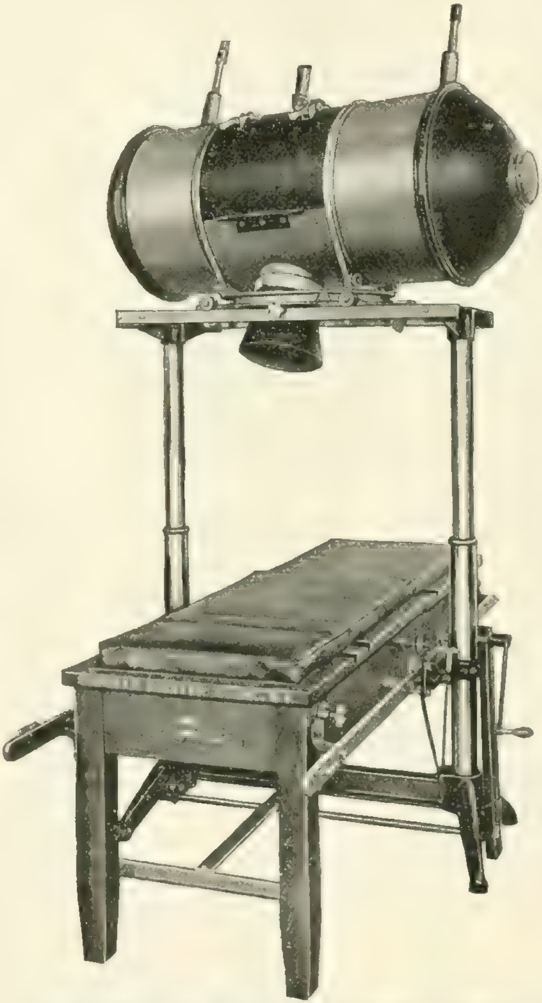
T-E X-RAY LABORATORY - 511 SENECA ST. - BETHLEHEM, PA.

WAPPLER

PROTECTION—EFFICIENCY and DURABILITY
HAVE ALL BEEN PROVED BY THE TEST OF TIME—

Wappler Deep Therapy Equipment

IS UNQUESTIONABLY ENDORSED
BY MANY PROMINENT USERS (Names on Request)



The Wappler Deep Therapy Tube Holder and Table illustrated above provides a safe means for mounting the Deep Therapy tube during treatments.

The Wappler Deep Therapy equipment is complete! An apparatus is offered which not only produces a most efficient X-Ray for massive dose treatment—but also provides a proper and safe means for mounting the X-Ray tube during this treatment. ¶ Wappler Deep Therapy X-Ray Transformers have a record of two years' solid use behind them —and the users unquestionably endorse the apparatus. ¶ The price is remarkably reasonable. ¶ Write now for Catalog Bulletin #99-2, describing the complete Wappler Deep Therapy X-Ray Equipment.

WAPPLER ELECTRIC
COMPANY, Inc.
LONG ISLAND CITY
N. Y., U. S. A.

"Best by Test—Regardless of Price"

To All Radiologists:

THE SUPERIORITY OF FRENCH INTENSIFYING SCREENS is fast being recognized throughout the country, borne out by the steadily increasing sales since their introduction here. Your X-Ray dealer, if fair and considering only your welfare, will concede this Screen the best and most economical buy for you, despite cheaper Screens, new experiments, and others "just as good." If he is not familiar with the French Screen, or questions it in any way, we stand ready to convince you by your own actual tests. Your money is being spent, and the selection of the best and most economical Screen for your work is important enough to warrant personal attention.

SPEED is the primary mission of Screens, and the Screen accomplishing this mission best, is the best. The French Screen is 25% *faster* than any other Screen on the market today, and in addition gives you a range of detail not possessed by other Screens, which is invaluable to accurate diagnosing. You also procure a film you are proud to show your fellow practitioners.

The Screen is furnished with our special, washable protective covering, which we replace once a year for $1.00. While Foreign Exchange remains at its present low rate, we give you the benefit of our saving in cost, and until further notice quote the following prices:

SIZE	EACH	PAIR	SIZE	EACH	PAIR
5 x 7	$ 6.00	$12.00	10 x 12	$16 00	$32.00
6½ x 8½	8.00	16.00	11 x 14	22.50	45.00
8 x 10	10.00	20.00	14 x 17	30.00	60.00

Sold with a Three-Year Guarantee and a Yearly Screen Service for the same time, at a cost of $1.00 per Screen per Year. What Does This Mean to You, and Can You Buy any Other Screen With This Guarantee and Service? Used by leading Roentgenologists throughout the country, you will find this Screen far ahead of any Screen you have heretofore used.

FRENCH FLUOROSCOPIC SCREENS ARE ALSO THE BEST, giving a clear, brilliant image with a minimum of X-Ray power. Offered at a big saving to you. In all sizes—prices upon request.

Let us send you samples of French Screens and estimate upon your Screen and Cassette requirements

THE FRENCH SCREEN COMPANY

Sole U. S. Distributors of French Screens

406 McKerchey Bldg. - 2631 Woodward Ave. - Detroit, Mich.

℞ Ritz-Carlton—
ATLANTIC CITY

Pure air—pure food—pure enjoyment. These three great essentials of life form the never changing doctrine of this famous all-year resort. With its mild, equable climate, due to its close proximity to the Gulf Stream, bright blue skies, golden sunshine, bracing sea air, exhilarating ozone, congenial society and expansive marine panorama—the Ritz-Carlton offers its guests all the joys of an ocean voyage.

Traverse the Boardwalk in an open or closed rolling chair with the care-free promenaders; recline in the Hotel solarium deck chairs or loaf about in the sun parlors or open pavilions.

Five hundred spacious rooms with individual salt and fresh water baths. Grill, Superior Music, Dancing, Theatres, Horseback Riding. Golf the year round.

Single rooms from $5.00 up : Double rooms from $8.00 up
Restaurant a la carte or three table d'hote meals $6.00 per day
Bathing facilities directly from rooms

New Hydriatric and
Electro-Therapeutic
Department.

The Ritz-Carlton Hotel - Gustave Tott, *Manager*

X-OGRAPH
ULTRA-RAPID DURABLE
INTENSIFYING SCREENS

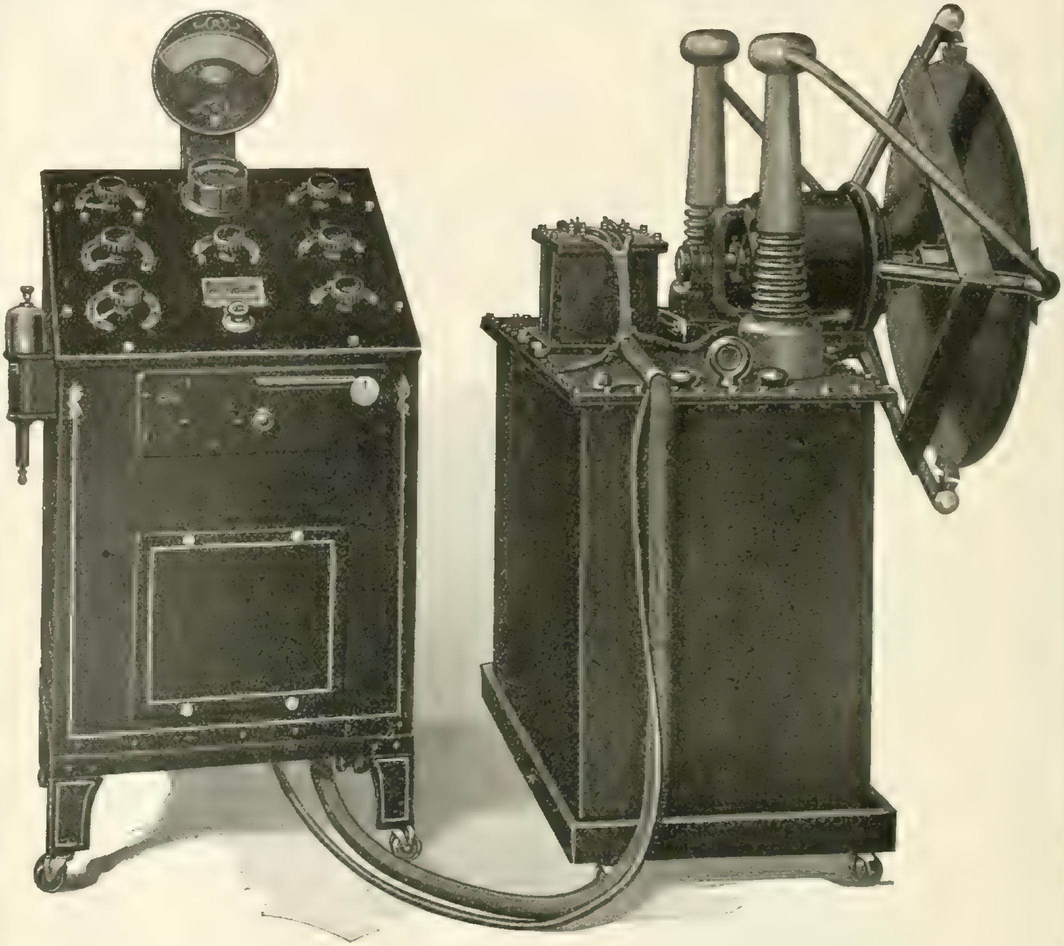
Just what the name implies—a combination of speed and durability which you cannot find elsewhere in the world.

BUILT FOR QUALITY—
SOLD FOR QUANTITY

Price per set of two screens—

8 x 10	10 x 12	11 x 14	14 x 17
$15.00	22.50	29.00	45.00

BUCK X-OGRAPH
COMPANY
ST. LOUIS, MO.



DO NOT BE MISLED BY

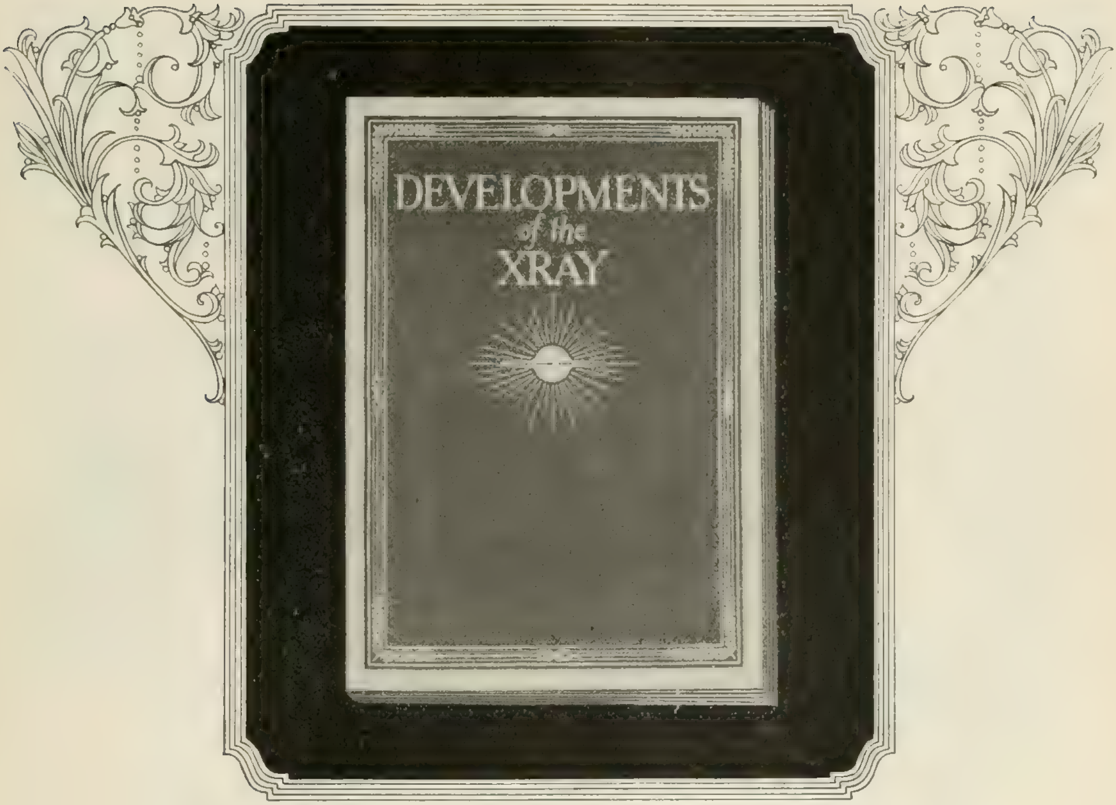
Spectacular Machines, Claims and Prices

Kelley-Koett still build and leads them all with serviceable, continuous duty X-Ray Transformers, where X-Ray output counts, not Psychological Effect. Write for bulletin # 1—200 kv. 30 m.a. machines.

K. & B. Electrical Equipment Co., Inc.

127 EAST 23rd STREET, NEW YORK, N. Y.

Boston - Buffalo - New Haven - Troy - Newark



This Newly Written 72-Page Brochure

Sent free to any registered Physician or Surgeon

Contained in the booklet reproduced above is a fully illustrated history of the X-Ray, starting with the discovery by Roentgen and leading up to the most recent developments as brought to their present day perfection by The Kelley-Koett Mfg. Co.

The edition is limited—so write today on your own letterhead for a copy. It will entail no obligation on your part.

The Kelley-Koett Manufacturing Company
Covington, Kentucky

CHALFONTE-HADDON HALL
ATLANTIC CITY

Hospitable, homelike, always open, always welcoming, Chalfonte-Haddon Hall, winter or summer, are the natural choice of cultivated, interesting people seeking real benefits from days of rest.

The sea air is gratefully mild and invigorating in winter—unbelievably mild, tempered by the breath of the Gulf Stream

Summer is just one of four enjoyable seasons here. Faces glow, eyes sparkle the whole year round. When surf bathing stops, riding begins, and horses canter on the beach. A live throng moves briskly up and down the Boardwalk. Golf is played under ideal conditions. While on the broad deck porches of Chalfonte-Haddon Hall, healthy fatigue suns itself and looks out to sea.

Pleasant companionship, perfect comfort; relished meals and deep sleep. The life gives new energy to tired bodies, new wit to jaded minds—and a lasting fondness for Chalfonte-Haddon Hall.

LEEDS and LIPPINCOTT
COMPANY

On the Beach and the Boardwalk

American Plan Only

Write for illustrated folder and rates

SWEETBRIAR SCREENS

The Sweetbriar Screen several years ago set a standard of *grainlessness* and still leads in this quality.

The *speed factor* has been increased until Sweetbriar is one of the fastest screens on the market.

The *waterproof face*, impervious to dirt and spots of developer, was added to satisfy the demands of careful Roentgenologists.

And a *waterproof back* was put on, so that Sweetbriar Screens can be washed with no danger of injury.

The *flexibility* that makes for contact is still retained.

Insist on your dealer supplying you with Sweetbriar Screens.

SWEETBRIAR LABORATORIES, Inc.

1220-1228 Hodgkiss Street, N. S. Pittsburgh, Pa.

HOEBER'S · NEW · BOOKS

TILNEY & RILEY:

THE FORM AND FUNCTIONS OF THE CENTRAL NERVOUS SYSTEM. *An Introduction to the Study of Nervous Diseases.* · Second Edition.

Large Octavo, Extra cloth, 1045 pages, 763 illus. : : : *net* $12.00

"Marks a distinct epoch not only in the teaching of nervous anatomy and physiology but also in the evolution of medical training in general."
Arch. Neurol. and Psychiat.

STEWART:

DIATHERMY AND ITS APPLICATION TO PNEUMONIA.

Duodecimo, Cloth, 226 pages, 45 illus., and 15 charts : : : *net* $3.00

"An unusually clear, but at the same time condensed, description of the physics, physiological effects and therapeutic indications of both medical and surgical diathermy."

MONTAGUE:

PRURITUS OF THE PERINEUM, *with Particular Reference to Pruritus Ani and Anal Pruritus and Contributions on Pruritus Vulvae and Scroti.*

Octavo, Cloth, 200 pp., 37 illus. : *net* $3.50

"A veritable encyclopedia on matters pertaining to pruritus vulvae, scroti and ani."

FABER:

NOSOGRAPHY IN MODERN INTERNAL MEDICINE.

With an Introduction by RUFUS COLE, M.D., Rockefeller Institute.

Octavo, Cloth, 235 pages, 21 full page illustrations : : : *net* $3.75

"A concise history of the development of medicine, showing clearly the influence of the various masters and schools on modern investigation and thought."

KERLEY & LEWALD:

DIGESTIVE DISTURBANCES IN INFANTS AND CHILDREN, *Roentgenologically Considered.*

4to, Cloth, 104 pp., 117 roentgen-ray studies on 54 plates and 49 text illus. : *net* $12.00

"The roentgenologist will find much of interest in this book and the pediatrician should find it of distinct value in adding to his understanding of that most useful adjunct in diagnosis—the x-ray."
Boston M. and S. J.

WEBB & RYDER:

RECOVERY RECORD, *for Use in Tuberculosis.*

Duodecimo (pocket size) semi-flexible cloth, 195 pages, 108 charts [Two years record] : : : : *net* $2.00

"A pervading spirit of cheerful optimism along with common sense admonition which is delightful and refreshing." *Boston M. and S. J.*

STONE:

BLOOD CHEMISTRY COLORIMETRIC METHODS. *For the General Practitioner, with Clinical Comments and Dietary Suggestions.*

8vo, Leatherette, 84 pp., 6 illus. : *net* $2.25

"This book contains suggestions for blood chemistry work, analysis of uric acid and gives important dietary rules with a chapter on diabetes including its treatment with insulin."

NOGUCHI:

LABORATORY DIAGNOSIS OF SYPHILIS. *A Manual for Students and Practitioners.*

Octavo, Cloth, 405 pp., 59 illus. : *net* $7.50

"This manual will be found valuable by all interested in the diagnosis of syphilis, and what medical man is not!"

Our complete catalogue and descriptive circulars will be sent upon request

PAUL B. HOEBER, INC., *Publishers*

Publishers of *The American Journal of Roentgenology & Radium Therapy*
and *Annals of Medical History*

67-69 EAST 59TH STREET NEW YORK, N. Y.

Free From Lag and Grain

NOT the least important characteristic of Patterson Fluoroscopic Screens is their grainlessness. As a result, the finest details may be studied. The operator is sure that he sees what is in the organism under examination and not a defect in the screen.

Complete absence of afterglow is another feature of the Patterson Fluoroscopic Screen. This freedom from lag makes it possible to see the outlines of moving parts with a clarity impossible with ordinary screens.

A descriptive circular will be sent on request.

For sale by your dealer

THE PATTERSON SCREEN CO.

Dept. A. J. R. *Towanda, Pa.*

X-RAY
FLUOROSCOPIC SCREEN
THE PATTERSON SCREEN CO
TOWANDA PA USA

Reg. U. S. Pat. Office

Special List of Publications

JAMES T. CASE, M.D., Battle Creek, Mich.	
THE X-RAY EXAMINATION OF THE ALIMENTARY TRACT.	
Four Sections. (New Edition)	$48.00
KENNON DUNHAM, M.D., Cincinnati, Ohio.	
THE X-RAY EXAMINATION OF THE CHEST FOR PULMONARY TUBERCULOSIS.	
Two Sections	$20.00
EMIL G. BECK, M.D., Chicago, Ill.	
LOCALIZATION OF FOREIGN BODIES BY MEANS OF STEREOSCOPIC ROENTGENOGRAMS.	
Two Sections	$27.50
NEW YORK ROENTGEN RAY SOCIETY.	
AMERICAN ATLAS OF STEREOROENTGENOLOGY.	
Ten Sections @ $3.50	$35.00
ARTHUR STEIN, M.D., & WM. H. STEWART, M.D., New York City.	
PNEUMO-PERITONEAL ROENTGEN RAY DIAGNOSIS.	
One Volume	$30.00
HARRY WESSLER, M.D., & LEOPOLD JACHES, M.D., New York City.	
CLINICAL ROENTGENOLOGY OF DISEASES OF THE CHEST.	
One Volume. In Press	$14.00
FRED H. ALBEE, M.D., New York City.	
1. FRACTURED HIP JOINT.	
(One Volume. Ten Stereos.)	$ 6.00
2. BONE GRAFT PEG FOR UNUNITED FRACTURES.	
(Two Volumes. Thirty-seven Stereos.), Forty-two pages	$19.00
EDWARD L. OATMAN, M.D., New York City.	
DIAGNOSTICS OF THE FUNDUS OCULI.	
Three Volumes and Cliniscope	$38.50
E. R. STROBEL, M.D., Baltimore, Md.	
THE DERMATOLOGICAL CLINIC.	
Two Sections	$25.00
CHAS. HUNTER DUNN, M.D., Boston, Mass.	
PEDIATRICS.	
Three Volumes	$27.00
HENRY HUN, M.D., Albany, N. Y.	
DIFFERENTIAL DIAGNOSIS OF THE DISEASES OF THE NERVOUS SYSTEM.	
(Third Edition. In Press)	$10.00
OTTO LERCH, M.D., New Orleans, La.	
RATIONAL THERAPY	$ 8.00
ELLIS BONIME, M.D., New York City.	
TUBERCULIN AND VACCINE FOR TUBERCULAR AFFECTIONS	$ 7.00

SOUTHWORTH COMPANY
PUBLISHERS TROY, NEW YORK

Agfa

STANDS FOR HIGHEST
QUALITY IN

X-RAY Films
AND
Plates

SPECIFY "AGFA" ON YOUR
NEXT ORDER TO YOUR DEALER

CARRIED IN STOCK BY ALL PROGRESSIVE X-RAY SUPPLY
HOUSES, OR DIRECT FROM

AGFA PRODUCTS, Inc.
formerly SAGAMORE CHEMICAL CO.

114-116 EAST 13TH ST. NEW YORK

Canadian Agents: CANADIAN AND FOREIGN AGENCY CO.
P. O. Box No. 1076, Montreal, Canada

New York Post-Graduate
MEDICAL SCHOOL AND HOSPITAL

For Information Address DEAN, 304 EAST 20TH STREET

"Have you any old discarded X-Ray Plates and X-Ray Films that you desire to dispose of? If so, turn the same into cash, as I purchase all sizes and any quantity, and pay cash for same."

INTENSIFYING SCREENS, single 5 x 7 mounted in cassette, Waite & Bartlett	$4.00 each
11 x 14 DRAWING BOARD with square and two angle rules	$ .25 each
COMPASS LOCALIZATION, Major Hirtz, with level and 4 compass rods and with brackets adjustable to any machine, packed in leather case	$5.00 each

Above prices f. o. b. Brooklyn, N. Y. : : Mail your order at once

I PURCHASE OLD X-RAY PLATES AND FILMS

CHARLES BENDER
94 PROSPECT PARK, S. W. Phone South 2823 BROOKLYN, N. Y.

CHRONOLOGIA MEDICA. *A Handlist of Persons, Periods and Events in the History of Medicine.*

By SIR D'ARCY POWER, K.B.E., M.B. Oxen, F.R.C.S., Eng., Consulting Surgeon to St. Bartholomew's Hospital, and C. J. S. THOMPSON, M.B.E., Associate of the Royal Academy of Medicine (Turin).

"The book in the handy form in which it is issued affords a ready means of verifying dates and other facts connected with the history of medicine and science generally. It gives in chronological order a brief biography of all those who have advanced the subjects of medicine and science. We find the book accurate and trustworthy." *Brit. M. J.*

DUODECIMO, CLOTH, THREE HUNDRED PAGES, EIGHTY-FOUR PORTRAITS : : : *Net* $3.50

PAUL B. HOEBER, INC., *Publishers*, 67-69 EAST 59TH ST., NEW YORK CITY
Publishers of ANNALS OF MEDICAL HISTORY

The most attractive X-Ray meal for the patient

Horlick's

THE ORIGINAL MALTED MILK

A most efficient and convenient suspension medium for the operator

Avoid imitations
Samples and literature prepaid

HORLICK'S, RACINE, WIS.

An Intensive Course for Doctors *in* RADIATION THERAPY

WILL BE GIVEN AT THE

STATE INSTITUTE FOR THE STUDY OF MALIGNANT DISEASE
113 High St., Buffalo, N. Y.

January 14th to January 26th, 1924
DAILY FROM 9 A.M. TO 5 P.M.

LECTURES IN PATHOLOGY OF MALIGNANCY
Burton T. Simpson, M.D.

DIAGNOSIS AND TREATMENTS WITH CLINICS
Bernard F. Schreiner, M.D.

PHYSICS OF RADIATION THERAPY
Wilhelm Stenstrom, Ph.D.

FEE $150.—Application with qualifications should be sent to the Director of the Institute at an early date.

RADIUM
STANDARD CHEMICAL CO

"Know the Company from Which You Buy"

Dependability—Service

THE character of service rendered by the Radium Chemical Company is typical of the Company's standing and long leadership in the industry.

Our service includes, among other things, a comprehensive and scientific course of instruction in the physics and the therapeutic use of radium. And our medical and technical experts are always available for conference, or for advice by letter.

RADIUM CHEMICAL CO.
PITTSBURGH, PA.

BOSTON NEW YORK CHICAGO SAN FRANCISCO DALLAS

"Should be one of the best medical sellers of the century."

THE
MECHANICS OF THE
DIGESTIVE TRACT

BY

WALTER C. ALVAREZ, M.D.
Assistant Professor of Research Medicine,
University of California Medical School

"You will be using the information in this book ten years from now because it will filter into the practice of medicine gradually and through many medical writers who will dilate, ream by ream, upon simply the facts as Alvarez presents them. Why not become one of these pioneers in applying these facts by reading this book now?"
Dr. E. H. Skinner in *The Medical Herald.*

"The book contains a great deal of original material, is of great interest, and can be recommended." *New York Medical Journal.*

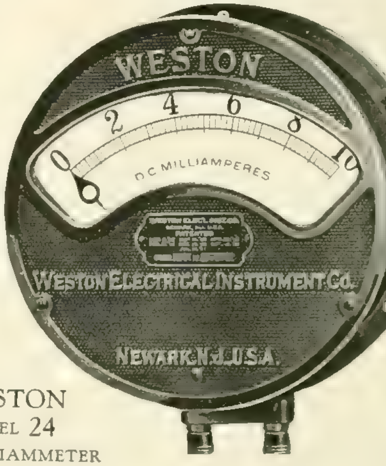
"An admirable book. The make-up of the book evidences the author's care and good taste. The typography is excellent. The bibliography is a model. The references are culled from the diversest sources, chemical, botanical, and zoological; old and new; yet they are not diffuse but bear exactly on the end Alvarez has in view. The book is worth reading and studying."
The California State Journal of Medicine.

"This is a highly scientific book and well deserving of the most careful study."
The Chicago Medical Recorder.

8VO. CLOTH, XII + 192 PAGES, 22 ILLUS.
PRICE $3.50 *Net*

Published by PAUL B. HOEBER
67-69 EAST 59TH ST., NEW YORK CITY

Uniformly
GOOD
Results



WESTON
MODEL 24
MILLIAMMETER

THERE is no secret or mystery as to how to obtain uniformly good results from Coolidge Tubes. Weston instruments assure them through their consistent accuracy and reliability. They are not affected by external electrostatic influences and give a life-time of satisfactory service. Have you investigated them ?

Write today for full information

WESTON ELECTRICAL INSTRUMENT CO.
160 WESTON AVE. NEWARK, N. J.
Branch Offices in All Principal Cities

WESTON
Electrical Indicating Instrument Authorities Since 1888
STANDARD-The World Over

COLLOIDAL RADIO ACTIVE LEAD

Intravenous Injections of Radio Active Lead afford opportunity of increasing Effectiveness of Radium Application in certain obstinate cases of Carcinoma.

Colloidal Sulphur for combating Septicemia and Toxemia accompanying malignant growths.

General Radium Corporation
Therapeutic Division
149 Broadway, New York

Do You Remember

When screen prices dropped just one year ago ?

And National Screen prices remained the same ?

That was because National Screen prices were right to begin with.

For 19 months, National Screens have sold at:

8 x 10	WASHABLE	$ 8.00
10 x 12	"	11.00
11 x 14	"	16.00
14 x 17	"	22.00

At Your Dealer

National X-Ray Screen Co.
INC.
220 South State Street
CHICAGO

THE ROENTGENOLOGISTS' EXCHANGE COLUMN

FOR SALE: 110 mgm. radium with Radium Chemical Company guarantee as to purity and U. S. Bureau of Standards certificate. This radium now in the form of two 25 mgm. tubes, four 12½ mgm. needles and a 10 mgm. plaque. Form and strength of applicator can be changed to suit requirements. Price well below the market. Address X-Lab, Care American Journal of Roentgenology and Radium Therapy.

THE WAPPLER ELECTRIC COMPANY, INC., LONG ISLAND CITY, N. Y. has some territory open for exclusive agencies. Their line is complete, including X-Ray for all purposes and Electro-Therapy. Only men or firms of responsibility and influence will be considered. Communications will be accepted in confidence.

Have a few Coolidge tubes, guaranteed, like new, 10 ma. horizontal. $60.00. Also other x-ray apparatus which I can dispose of cheap. Dr. Engel, 62 Hancock St., Brooklyn, N. Y.

WANTED: Experienced colleague to share cost of installation of a deep X-Ray Therapy apparatus (Veifa Works, Frankfurt) which is my property and completely paid for. Apparatus is at present in a warehouse in New York City. Address Dr. Dorian D. Wyser, c/o Dr. Benjamin, 237 Central Park West, New York, N. Y.

Lantern Slides - Prints - Photographs
Photomicrographs

PHOTOGRAPHY

to be of value to the physician, must be done with a thorough understanding of his requirements. Long experience and skill in photographic manipulation are essential, together with special equipment and some knowledge of Roentgenography.

We specialize in Photographic Service to the Medical Profession. May we serve you ?

❖

Campbell & Haulenbeek
Photographic Service to the Medical Profession
Phone Leonia 882 J. Palisades Park, N. J.

RADIUM EMANATION

A service accurate and dependable

RADIUM EMANATION supplied on short notice in any quantities or concentration desired.

A therapeutic measure more flexible than radium salts.

Our medical staff available for consultation as to technique, doseage and screenage.

New instruments developed to meet the requirements of the various specialties, viz., Urology, Gynecology, etc.

Illustration shows our new method of loading instruments with emanation "seeds," *insuring* definite disposal of "seeds" for implantation; affording protection against accidental loss, as well as making possible the implantation of a number of "seeds" through one portal of entry.

Telephone and telegraphic orders given prompt attention.
Shipments over reasonable distances practical.

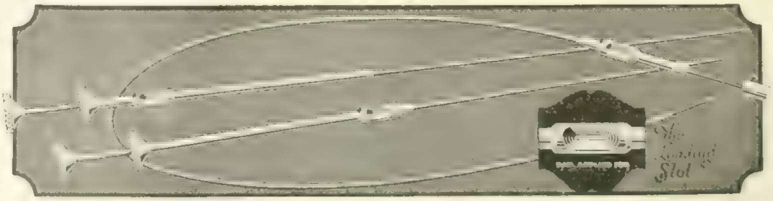
LITERATURE ON REQUEST

WILLIAM DUANE, Ph.D., D. Sc., Harvard University, *Consulting Physicist*

SERVICE
RECO
RADON

THE RADIUM EMANATION CORPORATION

256 *west 57th* STREET *Telephone* Circle 3649 NEW YORK CITY



RM
845
A45
v.10

The American journal of roentgenology, radium therapy and nuclear medicine

Biological
& Medical
Serials

1923

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

STORAGE